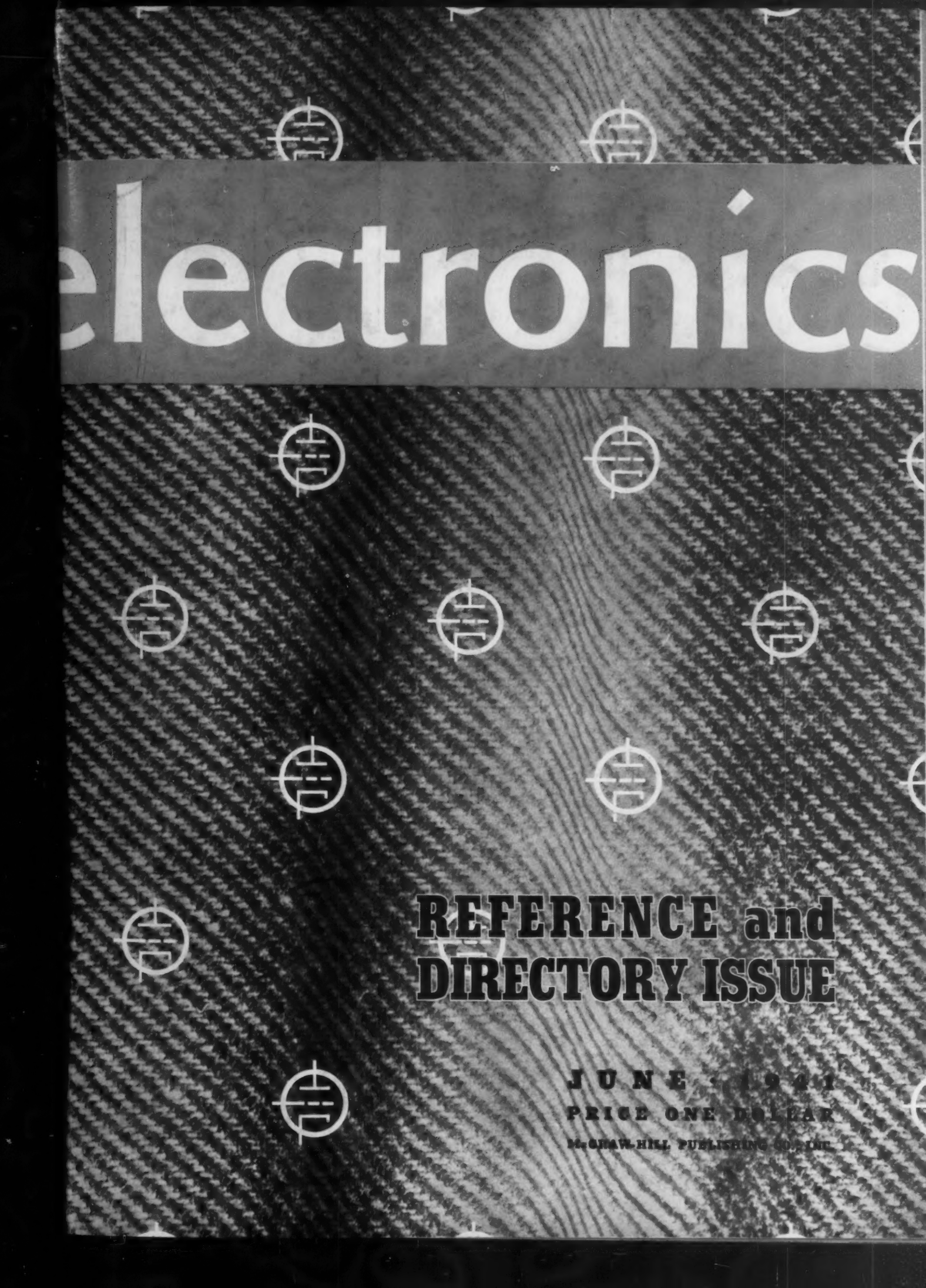

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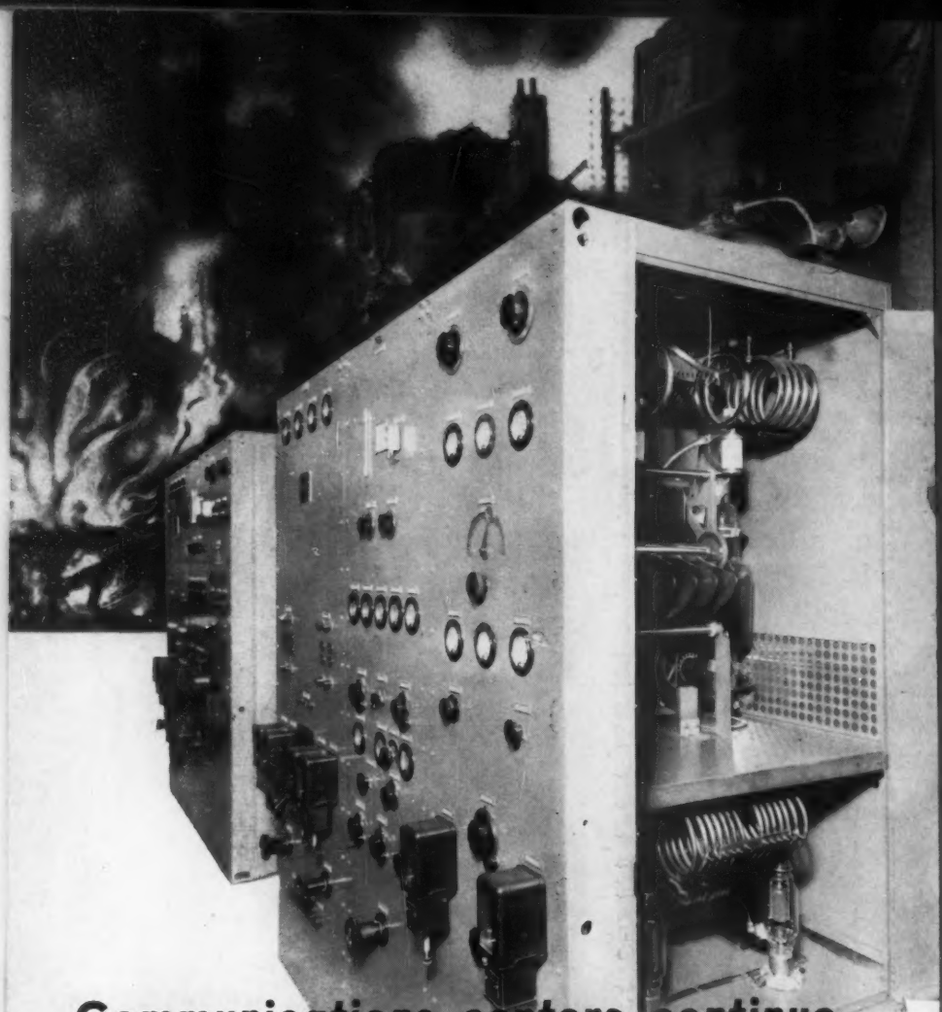

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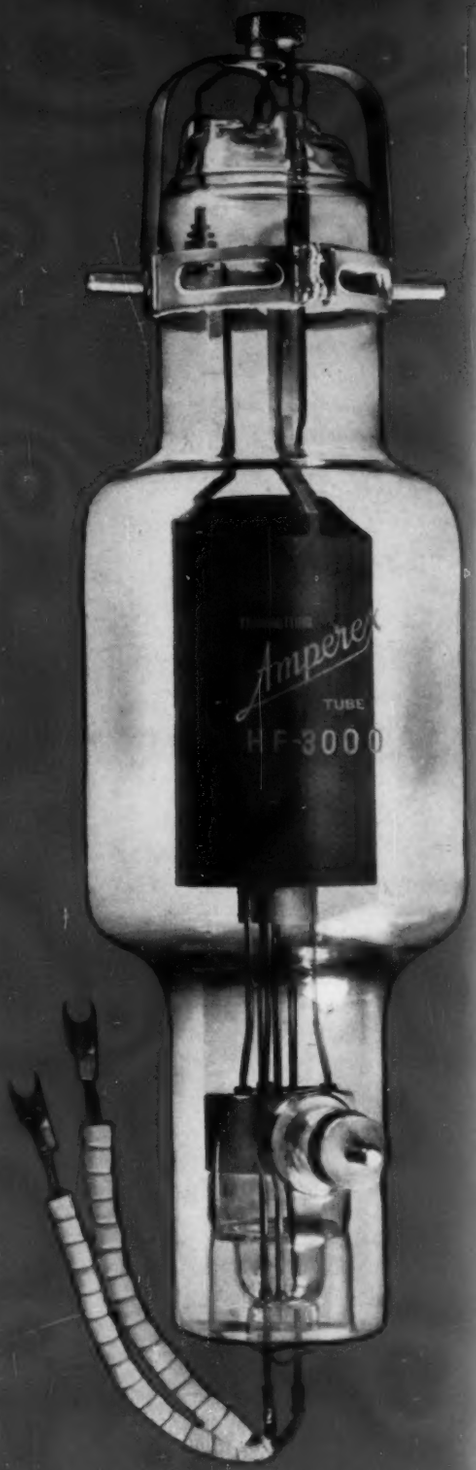

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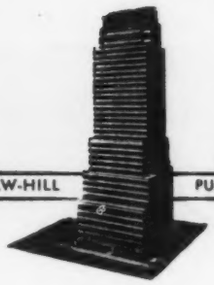

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ELECTRONICS REFERENCE ISSUE

THE editors present on the following pages an issue of ELECTRONICS devoted to reference data—tables, charts, and formulas—for engineers in the electronic fields. While in no sense a substitute for handbooks covering these fields, this Reference Issue is intended to serve as a compact source of material commonly used in electronic engineering, but difficult for the busy engineer to keep in his head. An alphabetical index appears on page 64.

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SECTION I: RADIO COMMUNICATION

Frequency Ranges[1]

Low radio frequencies:

(Long waves): 10 to 550 kc; 30,000 to 545 meters. Ground-wave range 0–1000 miles; sky-wave range 500–8000 miles.

Broadcast frequencies:

550 to 1600 kc; 545 to 187 meters. Ground-wave range 0–100 miles. Sky-wave range 100–1500 miles.

High radio frequencies:

(Short waves): 1600 to 30,000 kc; 187 to 10 m. Ground-wave range 1–50 miles; sky-wave range 50–8000 miles.

Ultrahigh frequencies:

(Ultrashort waves): 30 to 300 Mc: 10 to 1 m. Range 0–100 miles.

Microwave frequencies:

300 to 3000 Mc (1 m to 10 cm). Range limited to line of sight.

F.C.C. Frequency[1] Allocations

The following is a condensed table of allocations in the U.S.A.

Frequency channels, kilocycles	Allocation
10–103	Fixed, government
103–141	Coastal telegraph, government
143–193	Maritime calling, ship telegraph, fixed and coastal telegraph. (190 kc to state police and government)
194–391	Government, fixed, airport, aircraft (375 kc to direction finding)
392–548	Coastal telegraph, government, ship telegraph, aircraft, intership phone (500 kc to maritime calling and government)
550–1,600	Broadcasting (1,592 to Alaska services)
1,600–1,712	Geophysical, relay, police, government, experimental, marine fire, aviation, motion picture
1,716–2,004	Amateur
2,004–2,500	Experimental visual and relay broadcast, police, government, ship harbor, fixed, miscellaneous
2,504–3,497.5	Coastal harbor, government, aviation, fixed, miscellaneous
3,500–4,000	Amateur
4,005–6,000	Government, aviation, fixed
6,020–6,190	International broadcast, government
6,200–6,990	Coastal telegraph and phone, government, fixed, miscellaneous
7,000–7,300	Amateur
7,305–9,490	Government, fixed, aviation, ship telegraph, coastal telegraph, miscellaneous
9,510–9,690	International broadcast
9,710–11,000	Government, fixed aviation
11,010–11,685	Ship telegraph, maritime, calling, government, coastal telegraph, fixed, aviation, miscellaneous
11,710–11,890	International broadcast, government
11,910–13,990	Aviation, fixed, government, ship telegraph, coastal telegraph, miscellaneous
14,000–14,400	Amateur
14,410–15,085	Fixed
15,110–15,330	International broadcast, government
15,355–17,740	Fixed, government, aviation, ship and coastal telegraph, miscellaneous
17,660–17,840	International broadcast
17,860–21,440	Fixed, government, aviation
21,460–21,650	International broadcast, government
21,650–23,175	Coastal telegraph, government, ship telegraph, miscellaneous
23,200–25,000	Aviation, government, miscellaneous
25,025–26,975	Broadcast, government
27,000–27,975	Government, general communication
28,000–30,000	Amateur
30,000–42,000	Police, government, relay broadcast, coastal and ship harbor, miscellaneous
42,000–50,000	Broadcast and educational (F-M)
50,000–56,000	Television, fixed
56,000–60,000	Amateur
60,000–112,000	Government, television
112,000–116,000	Amateur
116,110–139,960	Broadcast, government, aviation, police, miscellaneous
140,100–143,880	Aviation
144,000–400,000	Government, television, fixed
400,000–401,000	Amateur
401,000 and above	Experimental

Frequency Tolerances[1]

Established by Cairo Convention

Frequency band in kc	Service	Percentage Tolerance
10–550	Fixed, land, mobile	0.1%
	Mobile 110–162 kc	0.3
	Mobile 365–515 kc	0.3
	Aircraft	0.3
550–1600	Broadcasting	20 cps
1600–6000	Fixed	0.01
	Land	0.02
	Mobile 1500–4000	0.05
	Mobile 4115–4165	0.05
	Mobile 5500–5550	0.05
	Mobile 4000–6000	0.02
	Aircraft	0.025
	Broadcasting	0.005
6000–30,000	Fixed	0.01
	Land	0.02
	Mobile 6200–6250	0.05
	Mobile 8230–8330	0.05
	Mobile 11,000	0.05
	Mobile 12.34–12.5 Mc	0.05
	Mobile 16.46–16.66 Mc	0.05
	Mobile 22–22.2 Mc	0.05
	Mobile — other frequencies	0.02
	Aircraft	0.025
	Broadcasting	0.005

Bandwidth Requirements[1]

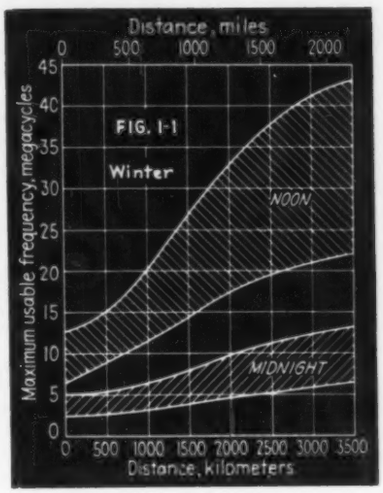
Service	Bandwidth Requirements
C-w Telegraph	Keying speed in bauds*
I-c-w Telegraph	Keying speed in bauds* plus twice modulation frequency
Commercial Telephone	6 to 8 kc
Broadcasting	10 to 30 kc
Television (Vestigial sideband)	6 Mc
F-m Broadcasting	200 kc
F-m Communication	40 kc
Facsimile	Number of picture elements per second plus twice sub-carrier frequency, if used

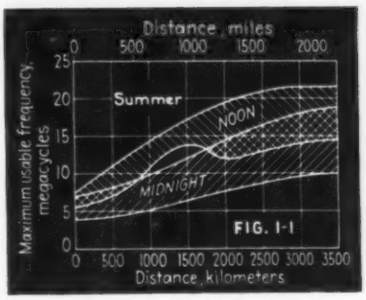
* One baud is 0.8 words per minute for a code having 8 dots or blanks per letter.

Amateur Allocations[10]

C-W telegraphy: (A-1 emission)

Band	Frequency Limits	Type License
160 m	1750–2050 kc	B or C
80 m	3500–4000 kc	B or C
40 m	7000–7300 kc	B or C
20 m	14,000–14,400 kc	B or C
10 m	28,000–30,000 kc	B or C
5 m	56,000–60,000 kc	B or C
2½ m	112–116 Mc	B or C
1¼ m	224–230 Mc	B or C
¾ m	400–401 Mc	B or C





A-m Telephony (A-3 emission)

160 m	1800–2050 kc	B or C
80 m	3900–4000 kc	A
20 m	14.15–14.25 Mc	A
10 m	28.5–30.0 Mc	B or C

5 m and above, same as c-w telegraph.

F-m telephony

5 m	58.5–60 Mc	B or C

2½ m and above, same as c-w telegraphy

Television

2½ m and above	B or C

Civil Aviation Allocations[1]

Service	Frequency in kc
Weather and radio range	200–400 [58 channels]
Airport traffic control	278
Plane-ground (night)	2900–3500
Plane-ground (day)	4100–6600 [80 channels]
Itinerant: calling and working (night)	3105, 3120
Itinerant: calling and working (day)	6210
U-h-f marker beacons	75,000
Transport company, point to point	2.7–18 Mc [28 channels]
Airport traffic control	129–132 Mc

Police Allocations

Municipal, State, and County

1610–1712 kc, 2318–2490 kc, 2804–2812 kc, 5135–5140 kc, 5195 kc. State: 190, 1730 kc. U-h-f (municipal): 30.5 to 40.0 Mc (29 channels).

International Broadcast Allocations

Band	Frequency Limits
50 meter	6000–6200 kc
31 meter	9500–9700 kc
25 meter	11,700–11,900 kc
20 meter	15,100–15,350 kc
17 meter	17,750–17,850 kc
14 meter	21,450–21,650 kc

Propagation—Choice of Frequency[5]

Figure 1-1 shows the maximum usable frequency for transmission over distances up to 2200 miles, at noon and midnight, during summer and winter at latitude 39° N[5] The upper and lower limits in each range correspond to the sunspot maximum and minimum respectively.

Propagation—Ground Wave

The field intensity[6]
due to the ground wave is given by

$$\epsilon = \frac{K\sqrt{P}A}{d} \text{ mv/m}$$

where K is antenna constant (195 for ¼-wave, 270 for ½-wave), P is power radiated in watts, d is the distance in miles, and A is an attenuation constant defined below.

The attenuation constant

$$A = \frac{2 + 0.3\rho}{2 + \rho + 0.6\rho^2}$$

where

$$\rho = \frac{9.38 + 10^{-21} f^2 d}{\sigma}$$

where f is the frequency of operation in kc, d is the distance in miles and σ is the soil or water conductivity in emu. The above equations neglect the effect of dielectric constant, which is permissible at frequencies lower than the value f_c specified in Table I (page 36)

Typical soil constants

See Table I (page 36).

Ground-wave propagation[8]

Values are given in Fig. 1-2 for average ground and sea water, for 1 kw power, with vertical ¼-wave antenna. For power P in kw, multiply field strength values by $\sqrt{P}$.

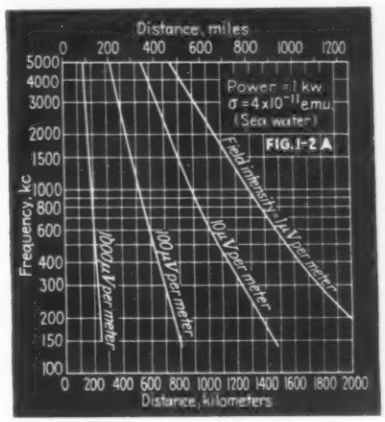
Propagation—Ultrahigh Frequencies[8, 14]

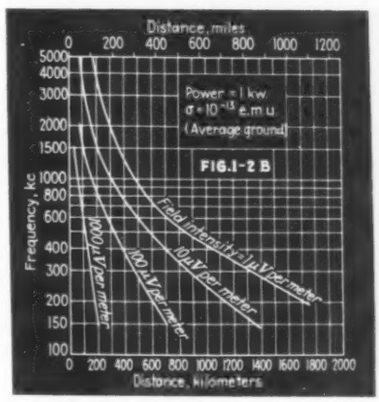
U-h-f field strength

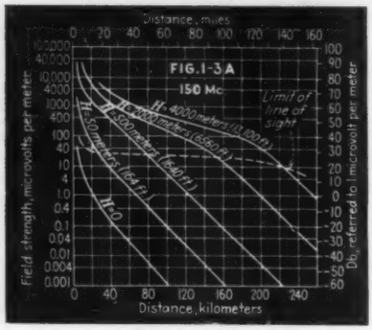
$$\epsilon = \frac{88\sqrt{P}\,AH}{r^2\ \lambda} \text{ volts/meter}$$

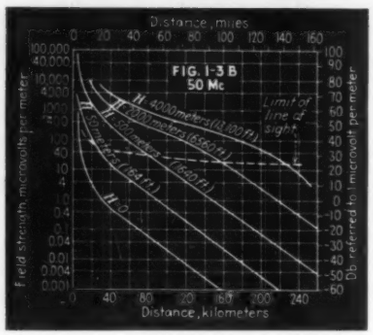
where P is the power radiated in watts from a half-wave dipole in direction of receiving point, H is transmitting antenna height in meters, A is receiving antenna height in meters, λ is the wavelength in meters, and r is the distance from the transmitting antenna in meters.

Example $P = 1$ kw, $A = 10$, $H = 100$, $r = 1000$ m (0.62 miles), $\lambda = 6$ m (50 Mc), $\epsilon = 0.46$ v/m. At $r = 10$ km (6.2 miles), $\epsilon = 4.6$ mv/m (other factors remaining unchanged).
Note: The heights A and H are the actual, not the effective, heights of the receiving and transmitting antennas, respectively.




Distance, miles
0 200 400 600 800 1000 1200
Power = 1 kw
σ = 10⁻¹³ e.m.u.
(Average ground)
FIG. 1-2 B
Field intensity 1 μV per meter
10 μV per meter
100 μV per meter
1000 μV per meter
Frequency, kc
5000 4000 3000 2000 1500 1000 800 600 400 300 200 150 100
0 200 400 600 800 1000 1200 1400 1600 1800 2000
Distance, kilometers


Distance, miles
FIG. 1-3A
150 Mc
Limit of line of sight
H 4000 meters (13,100 ft.)
H 2000 meters (6560 ft.)
H 1000 meters (3280 ft.)
H 500 meters (1640 ft.)
H 200 meters (656 ft.)
H 50 meters (164 ft.)
H=0
Field strength, microvolts per meter
Db referred to 1 microvolt per meter
Distance, kilometers


Distance, miles
FIG. 1-3B
50 Mc
Limit of line of sight
H 4000 meters (13,100 ft.)
H 2000 meters (6560 ft.)
H 1000 meters (3280 ft.)
H 500 meters (1640 ft.)
H 200 meters (656 ft.)
H 50 meters (164 ft.)
H=0
Field strength, microvolts per meter
Db referred to 1 microvolt per meter
Distance, kilometers

U-h-f propagation values:

Field strengths at 50 and 150 Mc, for 1 kw power for various values of antenna height H are given in Fig. 1–3.

Line of sight:

Distance of unobstructed line of sight between transmitting and receiving antennas is given in Fig. 1–4

Attenuation beyond horizon[14]:

Beyond the line of sight, the field strength of u-h-f waves decreases rapidly, according to

$$\epsilon = \epsilon_A (r_A/r)^N \ \mu v/m$$

where ϵ is field strength beyond horizon, ϵ_A is field strength at horizon in $\mu v/m$, r_A is distance to horizon in meters, r distance to point of observation in meters, and N is an exponent given in Fig. 1–5.

Propagation—Sky Wave[9]

The field strength due to the sky wave

$$\epsilon = \frac{3 \times 10^8 \sqrt{P} \sqrt{\theta/\sin\theta}\ e^{-A}}{d} \ \mu v/m$$

where P is power radiated in kw, d is distance to receiving point in km, θ is the angle at center of earth subtended by transmission path, in radians, A is an attenuation constant defined below, and $e = 2.718$.

TABLE I — TYPICAL SOIL CONSTANTS[7]

Type of soil or water	Conductivity (σ) emu	Dielectric Constant	f_c kc
Dry, sandy, rocky soil	10^{-14}	5	1400
Inland soil	10×10^{-14}	...	...
Moist ground	30×10^{-14}	30	7000
Salt water	4×10^{-11}	80	350,000

The attenuation constant:

$$A = 46\times10^{-6} f^{0.6} d$$

where f is the frequency in kc, and d is the distance in km.

Noise[2]

Impulse noise:

Peak and average values vary as the first power of the bandwidth. Effective values vary as the square root of the bandwidth.

Fluctuation noise:

Peak, effective and average values vary as the square root of the bandwidth.

Signal-to-noise ratios[3]

At receiver output:

Requirement	Signal-to-noise ratio
Perfect signal	60–80 db
Good quality	40–50 db
Intelligibility	10–30 db
Noise-free picture in television	40 db
Tolerable picture	20 db
Recognizable picture	5 db

Noise from electrical machinery[13]

Source	R-f volts line-to-line	R-f volts line-to-ground
Vacuum Cleaner	3 mv	3.5 mv
Electric razor	40	5.6
Diathermy	250	37
Portable tool	20	26
Automobile ignition*[4]	9–20	$\mu v/m/kc$ bandwidth

* Measured at 100 feet in antenna 35 feet high.

Thermal agitation noise:

$$\bar{e}^2 = 5.49\text{x}10^{-23}\ TZ\Delta f \text{ volts}^2$$

where $\bar{e}^2$ is the mean squared voltage arising from thermal agitation, T is the absolute temperature in deg K., Z is the resistance of the conductor in ohms, and Δf is the bandwidth in cps.
Example: $T = 300°$, $Z = 10{,}000$ ohms, $f = 20$ kc, $\bar{e}^2 = 3.3\text{x}10^{-12}$ (r-m-s voltage is 1.8 μv).

Shot-effect noise:

$$\bar{e}^2 = 3.18\text{x}10^{-19}\ IZ^2\Delta f \text{ volts}^2$$

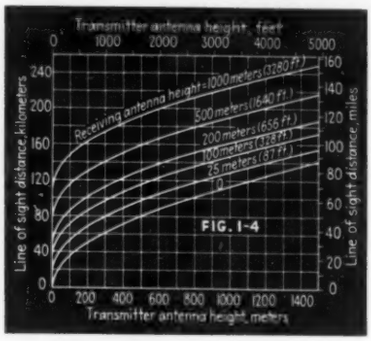
where $\bar{e}^2$ is the mean squared voltage arising from shot effect, I is the electron current in amperes, Z is the impedance through which electron current flows, in ohms, and Δf is the bandwidth in cps.
Example: $I = 10$ ma, $Z = 10{,}000$ ohms, $f = 20$ kc, $\bar{e}^2 = 7.4\text{x}10^{-9}$ (r-m-s value is 86 μv).

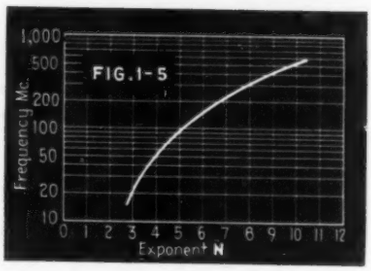
Antennas—Radiation

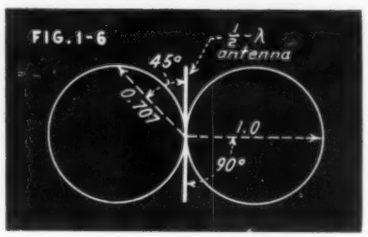
The field strength ϵ due to a linear antenna in free space is

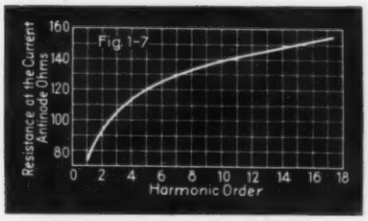
$$\epsilon = \frac{60\pi H\sqrt{W/R}}{\lambda d} \text{ volts per meter}$$

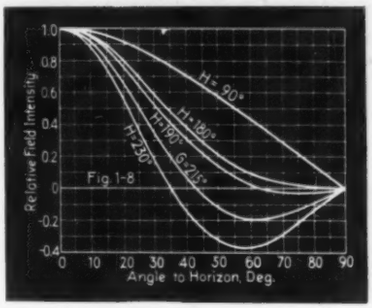
where H is the effective height in meters, W is the radiated power in watts, R the radiation resistance in ohms, λ the wave-











length in meters, and d the distance in meters from the antenna to the point of observation.

For a half-wave antenna fed at the center (doublet or dipole), $H = \lambda/\pi$, and $R = 73$ ohms.

Half-wave Antennas[10] (Hertz)

Physical length:

$$L = \frac{468}{f} \text{ feet}$$

where f is the frequency of operation in Mc. Assumes length equal to 95 per cent of half wavelength in free space.

Directivity:

The directivity of radiation from a half-wave antenna in free space is given in Fig. 1–6.

Impedance:

At center of half-wave antenna the impedance is 73.3 ohms when exactly half wavelength long. When length is 0.95 of half-wavelength, the impedance is about 67 ohms.

Impedance at harmonics:

Fig. 1–7 gives the antenna impedance of a wire in free space at harmonics of the fundamental.

Quarter-wave Antennas[10] (Marconi)

Physical length:

From far end to ground or counterpoise

$$L = \frac{236}{f} \text{ feet}$$

where f is the frequency of operation in megacycles.

Impedance of vertical $\frac{1}{4}$-wave wire over perfectly conducting earth is 35.67 ohms.

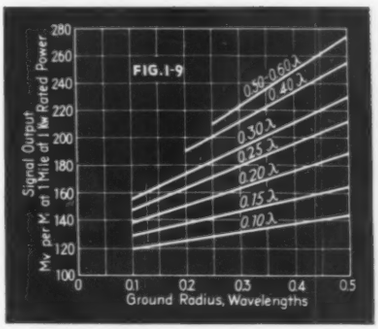
Base-loaded vertical antennas:

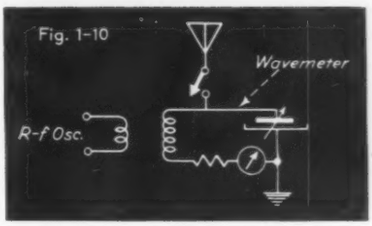
Ratio of one-quarter wavelength to physical length	Radiation resistance (ohms)
1.00	35.67
1.21	21.70
1.43	14.28
1.74	9.10
1.97	6.92
2.62	3.78
3.93	1.65
7.85	0.30

Tower Antennas[1]

Figure 1–8 gives the relative field intensity for tower antennas of different heights, in electrical degrees (360° = full wavelength) at different angles above the horizon.

The field intensity from a tower antenna is shown in Fig. 1–9, for different radii of ground system and different electrical lengths. For powers greater than 1 kw, multiply field strength values by $\sqrt{P}$ where P is the operating power in kw.





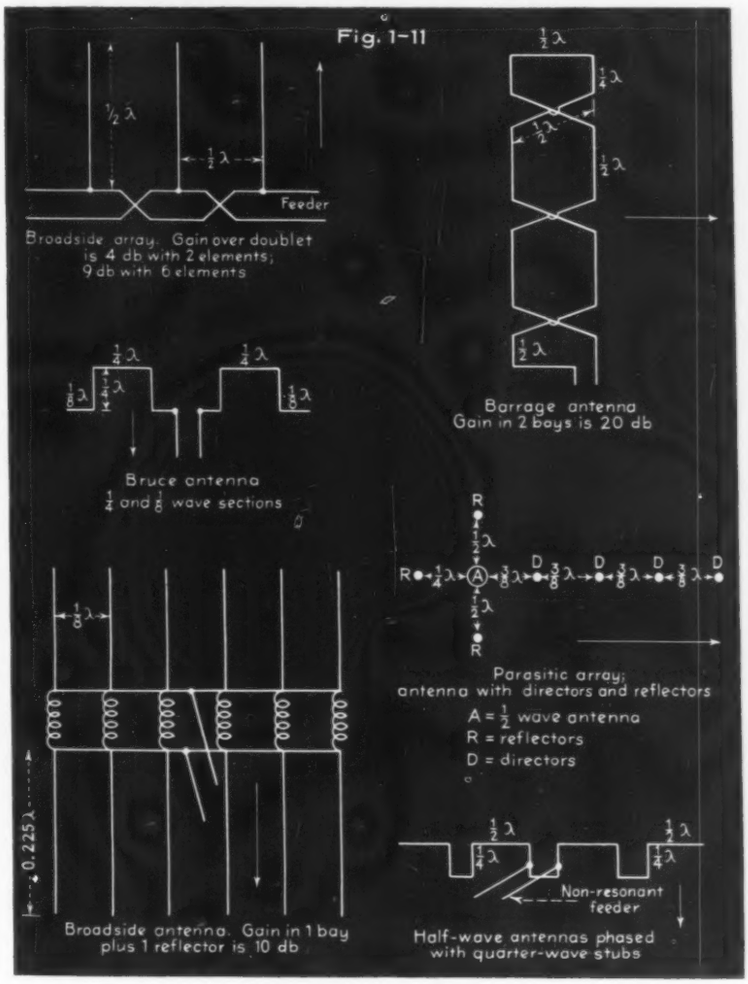


Fig. 1-11
Feeder
Broadside array. Gain over doublet is 4 db with 2 elements; 9 db with 6 elements
Barrage antenna
Gain in 2 bays is 20 db
Bruce antenna
¼ and ⅛ wave sections
Parasitic array; antenna with directors and reflectors
A = ½ wave antenna
R = reflectors
D = directors
0.225λ
Broadside antenna. Gain in 1 bay plus 1 reflector is 10 db
Non-resonant feeder
Half-wave antennas phased with quarter-wave stubs

SECTION I: RADIO COMMUNICATION

Frequency Ranges [1]

Low radio frequencies:

(Long waves): 10 to 550 kc; 30,000 to 545 meters. Ground-wave range 0–1000 miles; sky-wave range 500–8000 miles.

Broadcast frequencies:

550 to 1600 kc; 545 to 187 meters. Ground-wave range 0–100 miles. Sky-wave range 100–1500 miles.

High radio frequencies:

(Short waves): 1600 to 30,000 kc; 187 to 10 m. Ground-wave range 1–50 miles; sky-wave range 50–8000 miles.

Ultrahigh frequencies:

(Ultrashort waves): 30 to 300 Mc: 10 to 1 m. Range 0–100 miles.

Microwave frequencies:

300 to 3000 Mc (1 m to 10 cm). Range limited to line of sight.

F.C.C. Frequency [1] Allocations

The following is a condensed table of allocations in the U.S.A.

Frequency channels, kilocycles	Allocation
10–103	Fixed, government
103–141	Coastal telegraph, government
143–193	Maritime calling, ship telegraph, fixed and coastal telegraph. (190 kc to state police and government)
194–391	Government, fixed, airport, aircraft (375 kc to direction finding)
392–548	Coastal telegraph, government, ship telegraph, aircraft, intership phone (500 kc to maritime calling and government)
550–1,600	Broadcasting (1,592 to Alaska services)
1,600–1,712	Geophysical, relay, police, government, experimental, marine fire, aviation, motion picture
1,716–2,004	Amateur
2,004–2,500	Experimental visual and relay broadcast, police, government, ship harbor, fixed, miscellaneous
2,504–3,497.5	Coastal harbor, government, aviation, fixed, miscellaneous
3,500–4,000	Amateur
4,005–6,000	Government, aviation, fixed
6,020–6,190	International broadcast, government
6,200–6,990	Coastal telegraph and phone, government, fixed, miscellaneous
7,000–7,300	Amateur
7,305–9,490	Government, fixed, aviation, ship telegraph, coastal telegraph, miscellaneous
9,510–9,690	International broadcast
9,710–11,000	Government, fixed aviation
11,010–11,685	Ship telegraph, maritime, calling, government, coastal telegraph, fixed, aviation, miscellaneous
11,710–11,890	International broadcast, government
11,910–13,990	Aviation, fixed, government, ship telegraph, coastal telegraph, miscellaneous
14,000–14,400	Amateur
14,410–15,085	Fixed
15,110–15,330	International broadcast, government
15,355–17,740	Fixed, government, aviation, ship and coastal telegraph, miscellaneous
17,660–17,840	International broadcast
17,860–21,440	Fixed, government, aviation
21,460–21,650	International broadcast, government
21,650–23,175	Coastal telegraph, government, ship telegraph, miscellaneous
23,200–25,000	Aviation, government, miscellaneous
25,025–26,975	Broadcast, government
27,000–27,975	Government, general communication
28,000–30,000	Amateur
30,000–42,000	Police, government, relay broadcast, coastal and ship harbor, miscellaneous
42,000–50,000	Broadcast and educational (F-M)
50,000–56,000	Television, fixed
56,000–60,000	Amateur
60,000–112,000	Government, television
112,000–116,000	Amateur
116,110–139,960	Broadcast, government, aviation, police, miscellaneous
140,100–143,880	Aviation
144,000–400,000	Government, television, fixed
400,000–401,000	Amateur
401,000 and above	Experimental

Frequency Tolerances [1]

Established by Cairo Convention

Frequency band in kc	Service	Percentage Tolerance
10–550	Fixed, land, mobile	0.1%
	Mobile 110–162 kc	0.3
	Mobile 365–515 kc	0.3
	Aircraft	0.3
550–1600	Broadcasting	20 cps
1600–6000	Fixed	0.01
	Land	0.02
	Mobile 1500–4000	0.05
	Mobile 4115–4165	0.05
	Mobile 5500–5550	0.05
	Mobile 4000–6000	0.02
	Aircraft	0.025
	Broadcasting	0.005
6000–30,000	Fixed	0.01
	Land	0.02
	Mobile 6200–6250	0.05
	Mobile 8230–8330	0.05
	Mobile 11,000	0.05
	Mobile 12.34–12.5 Mc	0.05
	Mobile 16.46–16.66 Mc	0.05
	Mobile 22–22.2 Mc	0.05
	Mobile — other frequencies	0.02
	Aircraft	0.025
	Broadcasting	0.005

Bandwidth Requirements [1]

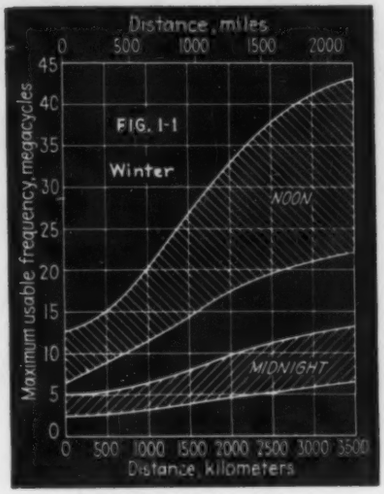
Service	Bandwidth Requirements
C-w Telegraph	Keying speed in bauds*
I-c-w Telegraph	Keying speed in bauds* plus twice modulation frequency
Commercial Telephone	6 to 8 kc
Broadcasting	10 to 30 kc
Television (Vestigial sideband)	6 Mc
F-m Broadcasting	200 kc
F-m Communication	40 kc
Facsimile	Number of picture elements per second plus twice sub-carrier frequency, if used

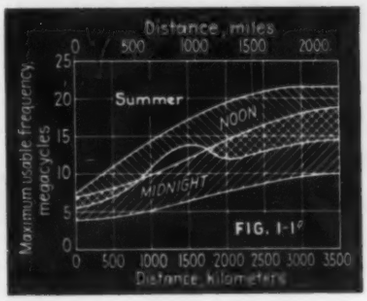
* One baud is 0.8 words per minute for a code having 8 dots or blanks per letter.

Amateur Allocations [10]

C-W telegraphy: (A-1 emission)

Band	Frequency Limits	Type License
160 m	1750–2050 kc	B or C
80 m	3500–4000 kc	B or C
40 m	7000–7300 kc	B or C
20 m	14,000–14,400 kc	B or C
10 m	28,000–30,000 kc	B or C
5 m	56,000–60,000 kc	B or C
2½ m	112–116 Mc	B or C
1¼ m	224–230 Mc	B or C
¾ m	400–401 Mc	B or C





A-m Telephony (A-3 emission)

160 m	1800–2050 kc	B or C
80 m	3900–4000 kc	A
20 m	14.15–14.25 Mc	A
10 m	28.5–30.0 Mc	B or C

5 m and above, same as c-w telegraph.

F-m telephony

5 m	58.5–60 Mc	B or C

2½ m and above, same as c-w telegraphy

Television

2½ m and above	B or C

Civil Aviation Allocations[1]

Service	Frequency in kc
Weather and radio range	200–400 [58 channels]
Airport traffic control	278
Plane-ground (night)	2900–3500
Plane-ground (day)	4100–6600 [80 channels]
Itinerant: calling and working (night)	3105, 3120
Itinerant: calling and working (day)	6210
U-h-f marker beacons	75,000
Transport company, point to point	2.7–18 Mc [28 channels]
Airport traffic control	129–132 Mc

Police Allocations

Municipal, State, and County

1610–1712 kc, 2318–2490 kc, 2804–2812 kc, 5135–5140 kc, 5195 kc. State: 190, 1730 kc. U-h-f (municipal): 30.5 to 40.0 Mc (29 channels).

International Broadcast Allocations

Band	Frequency Limits
50 meter	6000–6200 kc
31 meter	9500–9700 kc
25 meter	11,700–11,900 kc
20 meter	15,100–15,350 kc
17 meter	17,750–17,850 kc
14 meter	21,450–21,650 kc

Propagation—Choice of Frequency[5]

Figure 1-1 shows the maximum usable frequency for transmission over distances up to 2200 miles, at noon and midnight, during summer and winter at latitude 39° N[5] The upper and lower limits in each range correspond to the sunspot maximum and minimum respectively.

Propagation—Ground Wave

The field intensity[6] due to the ground wave is given by

$$\epsilon = \frac{K\sqrt{P}A}{d} \text{ mv/m}$$

where K is antenna constant (195 for ¼-wave, 270 for ½-wave), P is power radiated in watts, d is the distance in miles, and A is an attenuation constant defined below.

The attenuation constant

$$A = \frac{2 + 0.3\rho}{2 + \rho + 0.6\rho^2}$$

where

$$\rho = \frac{9.38 + 10^{-21} f^2 d}{\sigma}$$

where f is the frequency of operation in kc, d is the distance in miles and σ is the soil or water conductivity in emu. The above equations neglect the effect of dielectric constant, which is permissible at frequencies lower than the value f_c specified in Table I (page 36)

Typical soil constants

See Table I (page 36).

Ground-wave propagation[8]

Values are given in Fig. 1-2 for average ground and sea water, for 1 kw power, with vertical ¼-wave antenna. For power P in kw, multiply field strength values by $\sqrt{P}$.

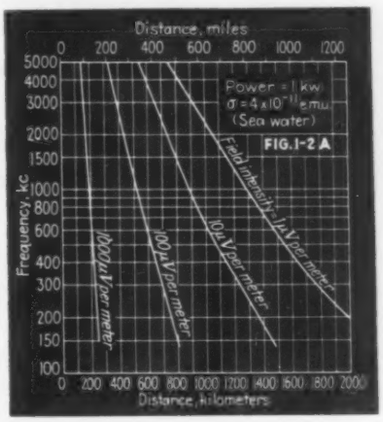
Propagation—Ultrahigh Frequencies[8, 14]

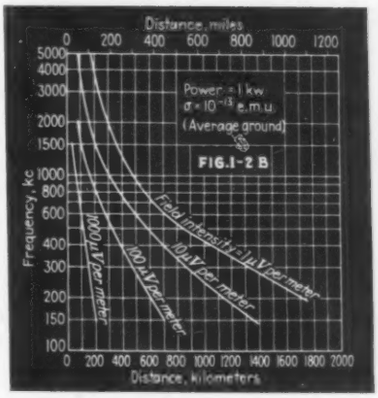
U-h-f field strength

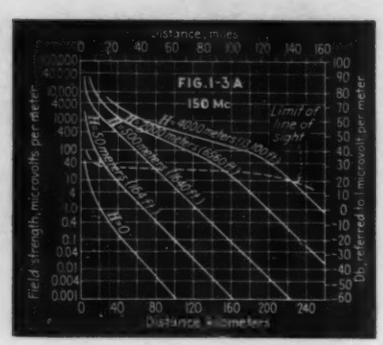
$$\epsilon = \frac{88\sqrt{P}\,AH}{r^2\ \lambda} \text{ volts/meter}$$

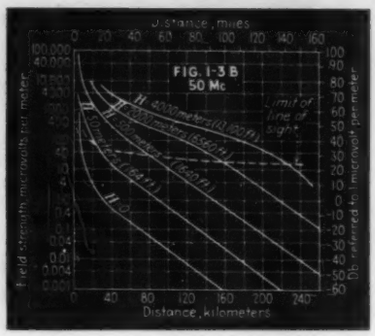
where P is the power radiated in watts from a half-wave dipole in direction of receiving point, H is transmitting antenna height in meters, A is receiving antenna height in meters, λ is the wavelength in meters, and r is the distance from the transmitting antenna in meters.

Example $P = 1$ kw, $A = 10$, $H = 100$, $r = 1000$ m (0.62 miles), $\lambda = 6$ m (50 Mc), $\epsilon = 0.46$ v/m. At $r = 10$ km (6.2 miles), $\epsilon = 4.6$ mv/m (other factors remaining unchanged).
Note: The heights A and H are the actual, not the effective, heights of the receiving and transmitting antennas, respectively.




Distance, miles
0 200 400 600 800 1000 1200
Power = 1 kw
σ = 10⁻¹³ e.m.u.
(Average ground)
FIG. 1-2 B
Field intensity = 1 μV per meter
10 μV per meter
100 μV per meter
1000 μV per meter
Frequency, kc
5000 4000 3000 2000 1500 1000 800 600 400 300 200 150 100
0 200 400 600 800 1000 1200 1400 1600 1800 2000
Distance, kilometers





U-h-f propagation values:

Field strengths at 50 and 150 Mc, for 1 kw power for various values of antenna height H are given in Fig. 1-3.

Line of sight:

Distance of unobstructed line of sight between transmitting and receiving antennas is given in Fig. 1-4

Attenuation beyond horizon[14]:

Beyond the line of sight, the field strength of u-h-f waves decreases rapidly, according to

$$\epsilon = \epsilon_h (r_h/r)^N \ \mu v/m$$

where ϵ is field strength beyond horizon, ϵ_h is field strength at horizon in μv/m, r_h is distance to horizon in meters, r distance to point of observation in meters, and N is an exponent given in Fig. 1-5.

Propagation—Sky Wave[9]

The field strength due to the sky wave

$$\epsilon = \frac{3 \times 10^5 \sqrt{P} \sqrt{\theta/\sin\theta}\ \varepsilon^{-A}}{d} \ \mu v/m$$

where P is power radiated in kw, d is distance to receiving point in km, θ is the angle at center of earth subtended by transmission path, in radians, A is an attenuation constant defined below, and $e = 2.718$.

TABLE I — TYPICAL SOIL CONSTANTS[7]

Type of soil or water	Conductivity (σ) emu	Dielectric Constant	f_c kc
Dry, sandy, rocky soil	10^{-14}	5	1400
Inland soil	10×10^{-14}	...	.....
Moist ground	30×10^{-14}	30	7000
Salt water	4×10^{-11}	80	350,000

The attenuation constant:

$$A = 46\times10^{-6} f^{0.6} d$$

where f is the frequency in kc, and d is the distance in km.

Noise[2]

Impulse noise:

Peak and average values vary as the first power of the bandwidth. Effective values vary as the square root of the bandwidth.

Fluctuation noise:

Peak, effective and average values vary as the square root of the bandwidth.

Signal-to-noise ratios[3]

At receiver output:

Requirement	Signal-to-noise ratio
Perfect signal	60–80 db
Good quality	40–50 db
Intelligibility	10–30 db
Noise-free picture in television	40 db
Tolerable picture	20 db
Recognizable picture	5 db

Noise from electrical machinery[13]

Source	R-f volts line-to-line	R-f volts line-to-ground
Vacuum Cleaner	3 mv	3.5 mv
Electric razor	40	5.6
Diathermy	250	37
Portable tool	20	26
Automobile ignition*[4]	9–20	μv/m/kc bandwidth

* Measured at 100 feet in antenna 35 feet high.

Thermal agitation noise:

$$\bar{e}^2 = 5.49\times10^{-23}\ TZ\Delta f \text{ volts}^2$$

where $\bar{e}^2$ is the mean squared voltage arising from thermal agitation, T is the absolute temperature in deg K., Z is the resistance of the conductor in ohms, and Δf is the bandwidth in cps.
Example: $T = 300°$, $Z = 10{,}000$ ohms, $f = 20$ kc, $\bar{e}^2 = 3.3\times10^{-12}$ (r-m-s voltage is 1.8 μv).

Shot-effect noise:

$$\bar{e}^2 = 3.18\times10^{-19}\ IZ^2\Delta f \text{ volts}^2$$

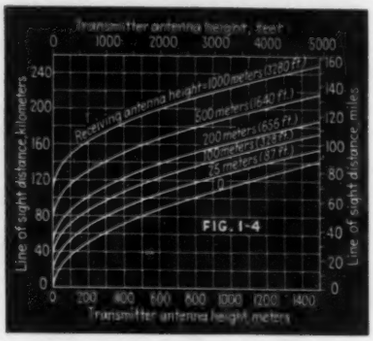
where $\bar{e}^2$ is the mean squared voltage arising from shot effect, I is the electron current in amperes, Z is the impedance through which electron current flows, in ohms, and Δf is the bandwidth in cps.
Example: $I = 10$ ma, $Z = 10{,}000$ ohms, $f = 20$ kc, $\bar{e}^2 = 7.4\times10^{-9}$ (r-m-s value is 86 μv).

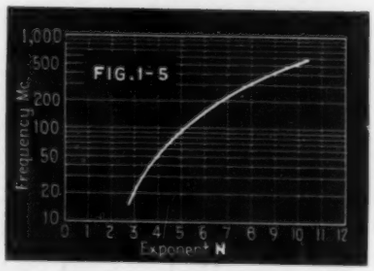
Antennas—Radiation

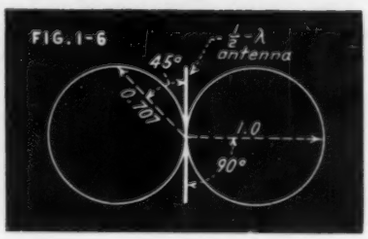
The field strength ϵ due to a linear antenna in free space is

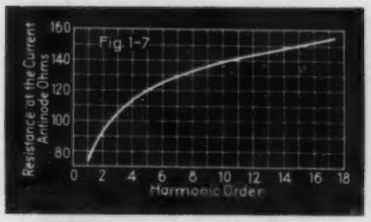
$$\epsilon = \frac{60\pi H\sqrt{W/R}}{\lambda d} \text{ volts per meter}$$

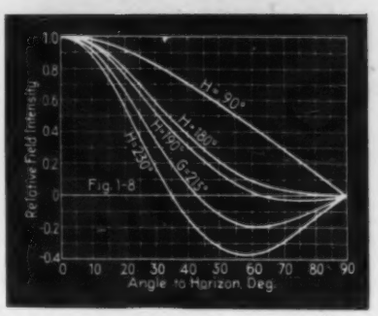
where H is the effective height in meters, W is the radiated power in watts, R the radiation resistance in ohms, λ the wave-











length in meters, and d the distance in meters from the antenna to the point of observation.

For a half-wave antenna fed at the center (doublet or dipole), $H = \lambda/\pi$, and $R = 73$ ohms.

Half-wave Antennas[10] (Hertz)

Physical length:

$$L = \frac{468}{f} \text{ feet}$$

where f is the frequency of operation in Mc. Assumes length equal to 95 per cent of half wavelength in free space.

Directivity:

The directivity of radiation from a half-wave antenna in free space is given in Fig. 1-6.

Impedance:

At center of half-wave antenna the impedance is 73.3 ohms when exactly half wavelength long. When length is 0.95 of half-wavelength, the impedance is about 67 ohms.

Impedance at harmonics:

Fig. 1-7 gives the antenna impedance of a wire in free space at harmonics of the fundamental.

Quarter-wave Antennas[10] (Marconi)

Physical length:

From far end to ground or counterpoise

$$L = \frac{236}{f} \text{ feet}$$

where f is the frequency of operation in megacycles.

Impedance of vertical $\frac{1}{4}$-wave wire over perfectly conducting earth is 35.67 ohms.

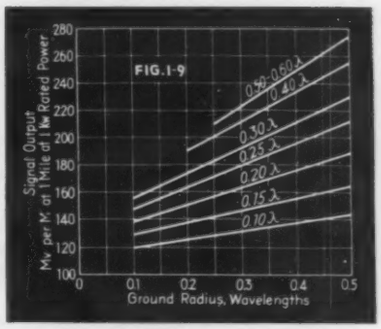
Base-loaded vertical antennas:

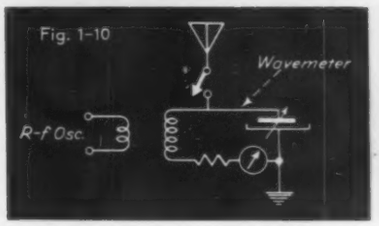
Ratio of one-quarter wavelength to physical length	Radiation resistance (ohms)
1.00	35.67
1.21	21.70
1.43	14.28
1.74	9.10
1.97	6.92
2.62	3.78
3.93	1.65
7.85	0.30

Tower Antennas[1]

Figure 1-8 gives the relative field intensity for tower antennas of different heights, in electrical degrees (360° = full wavelength) at different angles above the horizon.

The field intensity from a tower antenna is shown in Fig. 1-9, for different radii of ground system and different electrical lengths. For powers greater than 1 kw, multiply field strength values by $\sqrt{P}$ where P is the operating power in kw.





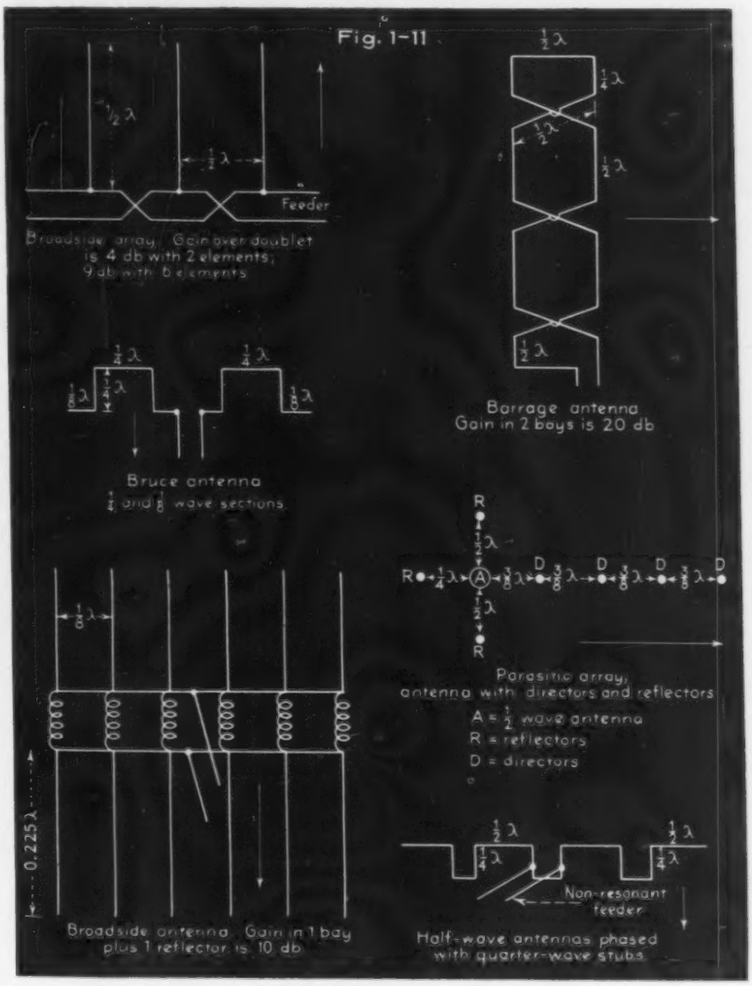


Fig. 1-11
Feeder
Broadside array. Gain over doublet is 4 db with 2 elements; 9 db with 6 elements
Barrage antenna
Gain in 2 bays is 20 db
Bruce antenna
⅛ and ⅛ wave sections
Parasitic array; antenna with directors and reflectors
A = ½ wave antenna
R = reflectors
D = directors
0.225λ
Broadside antenna. Gain in 1 bay plus 1 reflector is 10 db
Non-resonant feeder
Half-wave antennas phased with quarter-wave stubs

Measurement of Antenna Resistance

Figure 1–10 shows equipment used in measuring antenna resistance. The wavemeter is first grounded, with antenna disconnected, and reading for maximum indication noted. Then antenna is connected, meter retuned for maximum indication. Finally, calibrated reactances and resistances are added to wavemeter circuit in parallel until the same difference in readings is observed, indicating the value of resistance and reactance of the antenna, by substitution. This method is suitable for high as well as low antenna resistance values.

Multi-element Antenna Design

Fig. 1–11 shows typical multi-element antenna structures and their dimensions.

Transmission Lines—Open Wire [10, 11]

(See Fig. 1–12)

Impedance:

The surge or characteristic impedance of a two-wire parallel transmission line is

$$Z = 120 \log_e (2a/b) = 276 \log_{10} (2a/b)$$

where Z is the impedance in ohms, a is the spacing between wire centers in inches, and b is the diameter of the wire in inches. This equation applies when the wire spacing is large compared with the wire diameter.

Example: No. 14 wire (b = 0.063 in.) spaced 5 inches, Z = approximately 500 ohms. Parallel-wire transmission lines are usually constructed for impedances from 400 to 700 ohms.

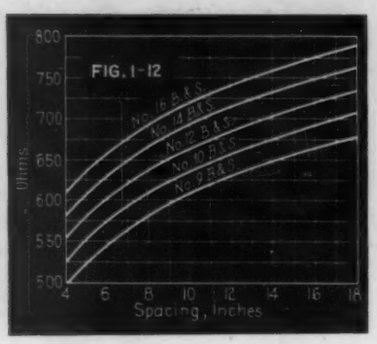
Attenuation:

Open-wire transmission lines display an attenuation of about

$$A = 0.1\sqrt{f} \text{ db per 1000 feet}$$

where f is the frequency of operation in Mc. The factor 0.1 varies from 0.09 to 0.20 depending on the quality of the insulation, etc.

Example: A 600-ohm open wire line of No. 4 copper displays 0.24 db loss per 1000 feet at 10 Mc.
Twisted pair (lamp cord) has a loss of about 1.5 db per wavelength when dry, and impedance of about 130 ohms.



Transmission Lines—Co-axial

Impedance:

$$Z = 138 \log_{10} (a/d) \text{ ohms}$$

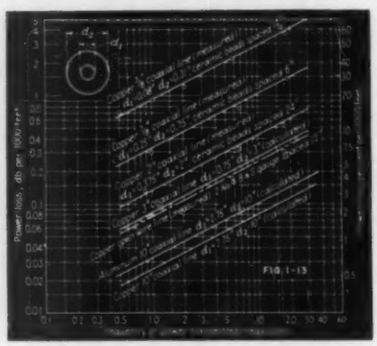
where a is the outside diameter of the inner conductor in inches, and d is the inner diameter of the outer conductor in inches.
Example: For 70-ohm line, a/d is 0.31. For a = 0.25 inch, d = 0.75 inch, Z = 66 ohms.

Attenuation:

(See Fig. 1–13)

$$A = \frac{0.256\sqrt{f}}{d} \text{ db per 1000 feet}$$

where f is the operating frequency in Mc, and d is the diameter of the outer conductor in inches.



Transmission Lines—Half- and Quarter-Wave

Dimensions:

The length L of a quarter wavelength line is

$$L = 246\ V/f \text{ feet}$$

where V is the percentage velocity of propagation given below, and f is the frequency of operation in Mc.

Velocity of propagation:

Type	Relative Velocity V
Two-wire	0.975
Parallel tubes	0.95
Coaxial, air insulated	0.85
Coaxial, rubber insulation	0.56–0.65
Twisted pair	0.56–0.65

Terminations:

(See Fig. 1–14)

Impedance looking into a half-wave line is equal to terminating impedance at far end and is independent of the characteristic impedance of the line. Half-wave sections may be used to measure impedances at a distance. For minimum reflection loss, termination at end of line should equal the characteristic impedance.

To match unequal impedances:

A quarter-wave line of surge impedance Z may be used, where

$$Z = \sqrt{Z_s Z_r} \text{ ohms}$$

where Z_s and Z_r are the terminating impedances at the sending and receiving ends, respectively, in ohms.
Example: To connect a 600-ohm transmission line to the center of a half-wave doublet (70 ohms), Z should be 205 ohms.

Transmission Line Stabilization [12]

Sections of transmission lines

have been used as frequency stabilizers in the range from 7 to 500 Mc. Coaxial lines are used, usually of copper. The design factors are as follows:

Inductance:

$$L = 2\times10^{-7} \log_e (b/a) \text{ henries per meter}$$

Capacitance:

$$C = \frac{10^{-9}}{18 \log_e (b/a)} \text{ farads per meter}$$

Resistance:

$$R = 41.6\times10^{-7}\sqrt{f}\,(1/a+1/b) \text{ ohms per meter}$$

where a is outer radius of inner conductor in cm, b is inner radius of outer conductor in cm, and f is frequency in cps.

The maximum Q:

For a copper line is

$$Q_{max} = 1460\ b/\sqrt{\lambda}$$

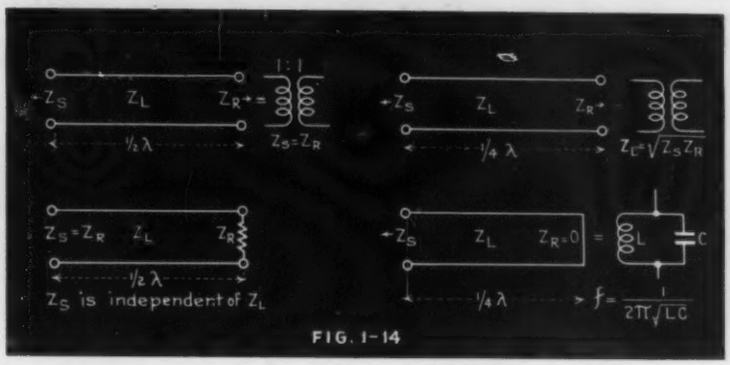


FIG. 1-14

where λ is the wavelength in meters and b is the outer conductor radius in cm. The maximum value of Q occurs when the ratio of b/a is 3.6.

Power loss:

The power loss in a quarter-wavelength tuned copper line is

$$P = \frac{I^2 R \lambda}{8} \text{ watts}$$

where I is current at maximum current point in amperes, λ is the wavelength in meters, and R is the resistance computed from the above equation for ¼-wave line.

Oscillating energy:

$$P' = \frac{I^2 \lambda}{16 \pi f C} \text{ volt amperes}$$

Where P' is the oscillating energy per ¼-wave section, λ is the wavelength in meters, f the frequency in cps, and C the capacitance in farads, computed from the above equation.

Figure of merit:

The Q of a tuned copper line is

$$Q = \frac{2\pi f I}{R} = \frac{1}{2\pi f C R}$$

where the symbols are defined above.

Voltage gradient:

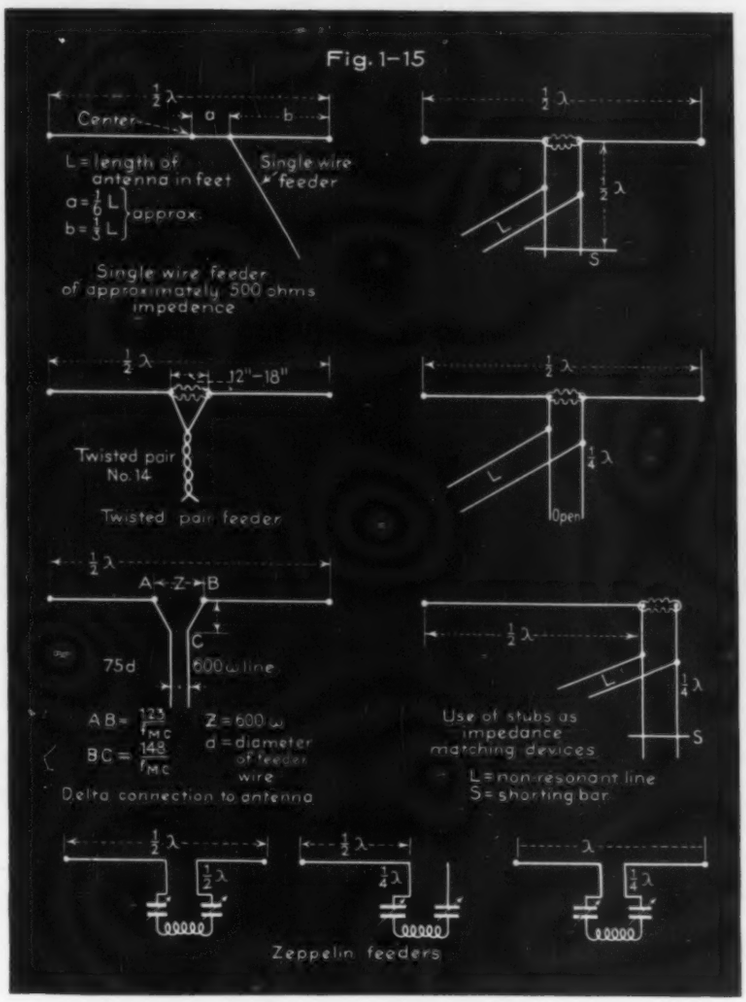
The maximum voltage gradient is

$$V.G. = \frac{E}{a \log_e (b/a)} \text{ volts/cm}$$

where E is voltage across the line at the voltage maximum, and a and b are defined above.

The minimum voltage gradient, for given maximum voltage, occurs when $b/a = 2.72$. The minimum voltage gradient for maximum oscillating energy occurs when $b/a = 1.65$.

Example: $f = 60$ Mc, inner conductor length 125 cm, $b = 60$ cm, $a = 6.5$ cm, $Q = 20{,}000$. For 10 watts power input, oscillating energy is 200,000 volt-amperes.



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SECTION 2: STANDARD BROADCASTING

Frequency Allocations

Basic standard broadcast frequencies for North America: 550 to 1600 kc. Allocations following March 29th, 1941, in accordance with the North American Regional Broadcasting Agreement (Havana Conference) are shown in the adjoining tables.[3]

UNITED STATES OF AMERICA

Class I	Class I	880 kc	1520 kc	600 kc	1270* kc	1430 kc
650 kc	and II	1000	Class II	610	1280*	1440
670	640 kc	1020	690	620*	1290*	1460
700	660	1030	740	630*	1300	1470
720	680	1070	860	790*	1310	1480
840	710	1080	940	910*	1320*	1590
890	750	1090	990	920	1330	1600*
1040	760	1100	1050	930	1350	Class IV
1060	770	1110	1560	950	1360	1230
1120	780	1130	Class III	960	1370*	1240
1180	810	1140	550	970	1380	1340
1200	820	1160	560	980	1390*	1400
1210	830	1170	570*	1150*	1410	1450
1500	850	1190	580	1250*	1420*	1490
1530	870	1510	590	1260		

* Also assigned to one or more class IV stations.

REPUBLIC OF CUBA

Class I	1460 kc	Class IV
1010 kc	1540	560 kc
Class II	1560	620
570	Class III	1230
590	550	1240
630	600	1250
690	790	1280
740	910	
800	930	1340
810	920	1320
830	950	1350
860	960	1360
900	970	1370
990	980	1380
1000	1150	1390
1050	1260	1400
1060	1290*	1410
1090	1300*	1430
1110	1310	1450
1130	1330*	1470
1190	1420*	1480
1220	1440*	1490
1270		1580

* Also assigned to one or mor class IV stations.

DOMINICAN REPUBLIC; 950 (III); 1090 (II); 1350 (IV); 1470 (IV).

HAITI: 1080 (II); 1230 (IV).

DOMINION OF CANADA

Class I	900 kc	1150 kc
540 kc	1220	1260
690	1570	1270
740	Class III	1410
860	550	1460
940	560	
990	580	1470
1070	600	1480*
1130	610	Class IV
1550	620	1230
Class I	630*	1240
and II	790	1340
1010	910	1380
Class II	930	1400
730	960	1450
800	980	1490

REPUBLIC OF MEXICO

Class I	1010 kc	1320 kc
730 kc	1110	1330*
800	1170	1350
900	Class III	1370*
940	600	1380
1050	610	1390*
1190	630	1410
1220	790	1420
1570	920	1430*
Class I	950	1440
and II	960*	1470
1090	970	1500
1140	980	1590
Class II	1150	Class IV
660	1250*	580
680	1260*	910
690	1270*	1340
810	1280*	1360
830	1290*	1400
860	1300	1450
990	1310*	1490

* Also assigned to one or more class IV stations

Allocations—Class of Stations

Class I-A: Dominant station operating on a clear channel, with power 50 kw or more.
Class I-B: Same as I-A, but 10 to 50 kw power.
Class II: Secondary station, operating on clear channel provided no interference is caused class I stations and subject to interference from class I stations. Power 250 watts to 50 kw.
Class III-A: Regional channel station, 1 to 5 kw power.
Class III-B: Regional channel station 500 watts to 1 kw (night), 5 kw (day).
Class IV: Local channel station, 100 to 250 watts power.

Allocation Standards[2]

Field Strength for Primary Service:

Area	Ground-Wave Field Intensity (mv/m)
City business or factory	10–50
City residential	2–10
Rural — winter	0.1–0.5
Northern Rural — summer	0.1–0.5
Southern Rural — summer	0.25–1.0

Interference:

The protected service contours and permissible interference signal for the various classes of station are given in Table I (page 41).

Interference Ratios:

The F.C.C. mileage separation tables are based on the following ratios of desired to undesired field strengths[2]

Channel Separation	Ratio
Same frequency—ground wave	20 to 1
Same frequency—10% sky-wave	20 to 1
Synchronized carriers	4 to 1
10 kc—ground wave	2 to 1
10 kc—sky wave	1 to 5
20 kc—ground wave	1 to 10
20 kc—sky wave	1 to 25
30 kc	1 to 50
40 kc and above	No restriction

Transmitter Performance[1, 2]

F.C.C. requirements:
Frequency tolerance:

±20 cps

Frequency monitor:

Must operate independent of frequency control to stability and accuracy of 5 parts per million.

Operating schedule:

Program for not less than two-thirds of authorized operation hours between 6 A.M. and 6 P.M., and between 6 P.M. and midnight.

F.C.C. Standards of Good Engineering Practice:

Modulation capability:

85 to 95 per cent with full power.

Distortion:

Not more than 5 per cent r-s-s from 0 to 84% modulation; not greater than 7.5% r-s-s from 85 to 95% modulation, measured at 50, 100, 400, 1000, 5000 and 7500 cps, including harmonics to the tenth, but not higher than 1,6000 cps.

Audio response:

Within ±2 db of the 1000 cps value from 100 to 5000 cps.

Noise:

Carrier hum and other noise (excluding studio and microphone noise) 50 db below 100 per cent modulation from 150 to 5000 cps; 40 db below outside this range.

Carrier Shift:

Not in excess on 5 per cent.

TABLE I — PROTECTED CONTOURS AND PERMISSIBLE INTERFERENCE[2]

Class of station	Class of channel used	Permissible power (Kw)	Signal intensity contour of area protected from objectionable interference: Day (GW)	Signal intensity contour of area protected from objectionable interference: Night (GW)	Permissible interfering signal on same channel[3]: Day (GW)	Permissible interfering signal on same channel[3]: Night [1]
1-A	Clear	50	SC 100 μv/m AC 500 μv/m	Not duplicated	5 μv/m	Not duplicated
I-B	Clear	10 to 50	SC 100 μv/m AC 500 μv/m	500 μv/m (50% sky wave)	5 μv/m	25 μv/m
II	Clear	0.25 to 50	500 μv/m	2500 μv/m	25 μv/m	125 μv/m
III-A	Regional	1 to 5	500 μv/m	2500 μv/m	25 μv/m	125 μv/m
III-B	Regional	0.5 to 1 night 5 day	500 μv/m	4000 μv/m	25 μv/m	200 μv/m
IV	Local	0.1 to 0 kw	500 μv/m	4000 μv/m	25 μv/m	200 μv/m

[1] Sky wave field intensity for 10 per cent or more of the time.
SC = Same channel.
AC = Adjacent channel.
GW = Ground Wave

Transmitter Cost[2]

F.C.C. estimates for initial cost of a new transmitter including installation and testing:

Power (watts) and Class	Cost ($)
100 (IV)	6,500
250 (IV)	8,500
250 (II)	10,000
500 (II and III)	22,500
1000 (II and III)	25,000
5000 (II and III)	40,000
10,000 (I and II)	65,000
25,000 (I and II)	175,000
50,000 (I and II)	200,000

Operating Power Measurement[1]

By indirect method, according to F.C.C. specifications, output power is determined by forming the product of the plate voltage and the total plate current of the last radio stage, multiplied by the efficiency values shown below:

Plate modulation in last stage:

Power, watts	Efficiency
100–1000	0.70
5000 and over	0.80

Power amplifier in last stage:

Class B	0.35
Class BC	0.65

Grid modulation in last stage:

Depending on type of tube used	0.25–0.35

Crystal Oscillators[4]

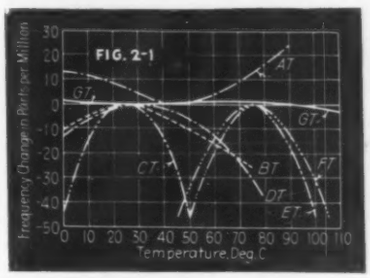
Frequency of oscillation of quartz:

$$f = K/t \text{ cps}$$

where K is 2.86×10^6 for X-cut crystals, and 1.96×10^6 for Y-cut, and t is the thickness of the crystal in millimeters. This frequency is the higher of two natural modes of vibration.

Temperature coefficient[5]

Figure 2-1 shows the temperature coefficients of various quartz crystal cuts.



Frequency of operation[2]

See Fig. 2-2.

Tuned plate:

$$f = \frac{1}{2\pi\sqrt{LC}} \text{ cps}$$

Oscillator Design[6]

To obtain good waveform and stable operation, peak stored energy per cycle should be at least twice the energy fed to the load per cycle. Under this condition, the Q of the tank circuit, including the equivalent resistance of the load is at least 4π, and the inductance and capacitance of the tuned circuit are given by

$$L = \frac{V^2}{8\pi^2 Pf} \text{ henries}$$

$$C = \frac{2P}{V^2 f} \text{ farads}$$

where V is the applied d-c plate voltage, P is the power in watts delivered to the load, and f the frequency of operation in cps.

Greater power output, with greater harmonic content, is obtained by increasing the L/C ratio.

Hartley:

$$f = \frac{1}{2\pi\sqrt{C(L_p + L_g + 2M)}} \text{ cps}$$

Colpitts:

$$f = \frac{1}{2\pi\sqrt{(LC_pC_g)/(C_g + C_p)}} \text{ cps}$$

Tuned-plate tuned-grid

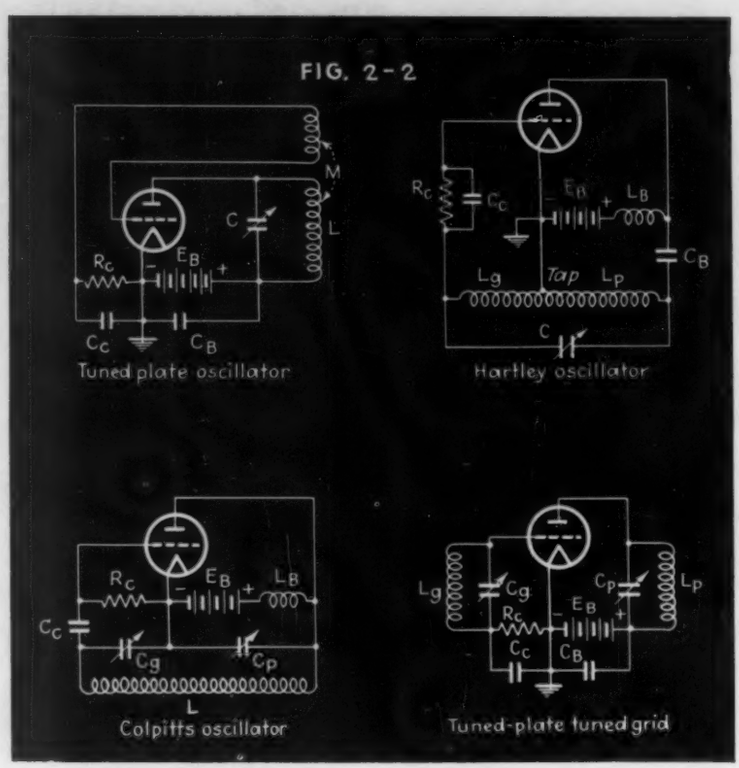
$$f = \frac{1}{2\pi\sqrt{C_gL_g}} \text{ cps}$$

where the L and M values are in henries and the C values in farads.

High-power crystal control circuit:

A circuit for generating 150 watts directly from a crystal, using a single beam-power tetrode is shown in Fig. 2-3.

FIG. 2-2



R-f Amplifiers—Class B[5]

Power input:

For a two-tube class B r-f amplifier, used in amplifying a modulated r-f signal, the power input to the two tubes is

$$P_{in} = \frac{2E_bI_{max}}{\pi} \text{ watts}$$

where E_b is the plate supply voltage in volts, I_{max} is the peak value of the plate current per tube in amperes.

Plate efficiency:

$$e = \frac{I_{max}R\pi}{4E_b} \times 100 \text{ per cent}$$

where I_{max} is the peak value plate current per tube, R the value of the load resistance in ohms in the plate circuit and E_b is the plate supply voltage in volts.

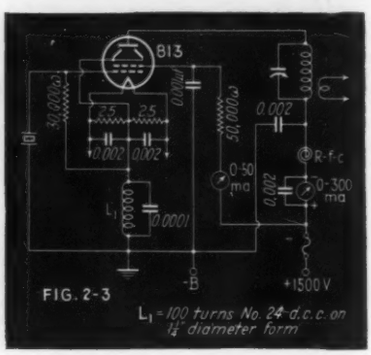


FIG. 2-3

L_1 = 100 turns No. 24 d.c.c. on 1¼" diameter form

Plate dissipation:

$$P_p = \frac{(4/\pi)I_{max}E_b - I_{max}^2R}{4} \text{ watts per}$$

tube where the symbols are defined in "Plate Efficiency" above.

Input resistance:

$$R_{in} = \frac{2r_p}{n^2} \text{ ohms}$$

where R_{in} is the effective resistance in series with each grid of the class B stage, r_p is the internal plate resistance of the driver amplifier tubes, and n is the turns ratio of the driver coupling circuit.

Power output:

The power output of a linear class B r-f amplifier at 100 per cent modulation is about 1.5 times the power output in the absence of modulation.

R-f Amplifiers—Class C

Power Output:

$P_o = eI_bE_b$ watts per tube where e is the stage efficiency, I_b is the plate current per tube in amperes and E_b is the plate supply voltage in volts.

Plate load resistance:

Since the plate current flows during only a short portion of the cycle, the actual value of the load resistance does not apply. However a fictitious value of load resistance R_a may be calculated from

$$R_a = \frac{R - eR}{e} \text{ ohms}$$

where R is the equivalent resistance in shunt with the tank circuit due to the load in ohms, and e is the plate circuit efficiency of the stage expressed as a fraction.

Class C bias:

The grid bias voltage of a class C stage is beyond cut-off at the peak plate voltage. For 100 per cent modulation, the bias should be 2 to 3 times the plate current cut-off point for normal plate voltage.

Neutralization:

Figure 2-4 shows typical grid and plate neutralizing circuits. In plate neutralization, the condition for the balance is

$$C_n/C_{gp} = L_1/L_2$$

where the symbols are shown in Fig. 2-4. For grid neutralization, the condition for balance is

$$C_n/C_k = C_{gp}/C_{pf}$$

where the symbols are shown in Fig. 2-4.

Plate circuit efficiency:

$$e = \frac{E_c}{4E_b}$$

where E_c is the peak value of the plate voltage and E_b is the plate supply voltage, both in volts. Values from 70 to 75 per cent are found in practice. The limiting efficiency is 78.5 per cent.

Modulation[5, 7]:

Power output of transmitter:

See Fig. 2–5.

$$P_o = kP_c \text{ watts}$$

where P_o is the power output with 100 per cent modulation, P_c is the unmodulated carrier power in watts, and k is 1.5 for sine-wave modulation and 1.25 for speech modulation.

Power output of plate modulator:

$$P_a = .5\ P_{in} \text{ watts}$$

where P_a is the average audio power developed by the plate modulator for 100 per cent modulation, and P_{in} is the power input to the modulated r-f stage when unmodulated, both in watts.

Plate modulating impedance:

$$Z_m = E_b/I_b \text{ ohms}$$

where Z_m is the impedance into which the modulating transformer looks, E_b is the d-c plate volts, and I_b the d-c plate amperes, both of the modulated r-f stage in the absence of modulation.

Plate modulation transformer ratio:

$$n = \sqrt{Z_p/Z_m}$$

where n is the ratio of primary turns to secondary turns, Z_p the load impedance specified for the modulator tube or tubes, and Z_m is the modulating impedance of the modulated class C amplifier (see "Plate Modulating Impedance", above).

Cathode modulating impedance:

See Fig. 2–5.

$$Z_m = mE_b/I_b \text{ ohms}$$

where m is the proportion of modulation assigned to the plate circuit, (m-1 assigned to the grid circuit), E_b and I_b are d-c values of plate voltage and current of modulated amplifier, in absence of modulation.

Cathode modulation relationships[7]:

Figure 2–6 shows values of power and efficiency for cathode-modulated amplifiers. P_{in} is the d-c input watts in per cent of plate modulation rating, P_o output carrier watts in per cent of plate modulation rating, P_a audio power in per cent of d-c watts input to r-f amplifier, and e plate circuit efficiency in per cent.

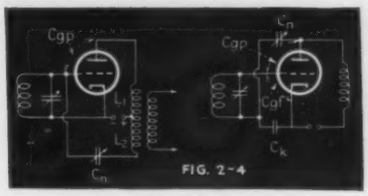


FIG. 2-4

Comparison of modulation methods:

Table II shows relative power and efficiencies of grid, cathode, and plate modulation, for 100 watts carrier output.

Grid modulation:

Power requirement is determined by required voltage swing and linearity; seldom more than 5 watts required. Plate circuit efficiency usually not more than 35%.

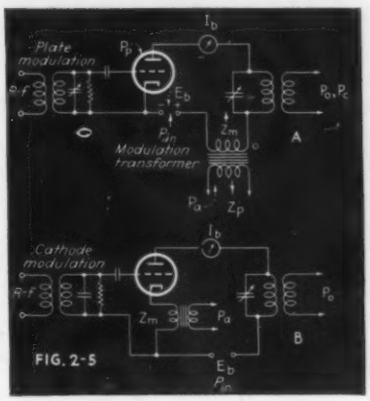


FIG. 2-5

TABLE II — MODULATION METHODS

	Plate Mod.	Cathode Modulation (m = 40%)	Cathode Modulation (m = 20%)	Grid-Bias Mod.
Carrier output, watts	100	100	100	100
D-C plate input, watts	129	178	228	300
Plate dissipation, watts	29	78	128	200
Audio power required, watts	65	36	23	—
Plate efficiency, per cent	77	56	44	33

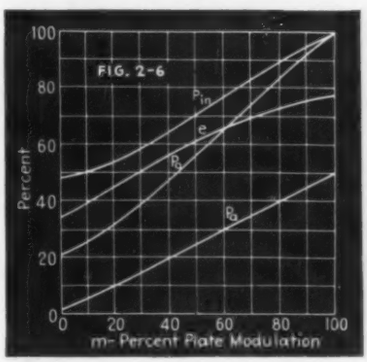


FIG. 2-6

Plate modulation, input power[5]:

$$P_{in} = \left[1 + \frac{m^2}{2}\right] E_b I_b \text{ watts}$$

where P_{in} is the average power input to the modulated r-f stage, m is the percentage modulation expressed as a decimal, E_b and I_b are the d-c values of plate current (amps) and voltage (volts) in the absence of modulation. The output power is ordinarily from 65 to 75 per cent of the input power.

Plate modulation—audio input power:

$$P_a = \frac{m^2}{2} E_b I_b \text{ watts}$$

where P_a is the input to the modulated r-f stage from the modulator, m is the modulation percentage expressed as a decimal, and E_b and I_b are the d-c plate supply volts and plate amperes of the r-f stage in the absence of modulation.

Plate modulation—plate loss:

$$P_p = (1 - e)\left(1 + \frac{m^2}{2}\right) E_b I_b \text{ watts}$$

where e is the plate circuit efficiency of the modulated stage expressed as a decimal, and the other symbols are defined under "Plate Modulation, Audio Input Power," above.

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5. Radio Engineering Handbook, 3rd Edition, 1941, McGraw-Hill.
6. Electrical Engineer's Handbook, Vol. V, 1936, Wiley.
7. A.R.R.L. Handbook, Eighteenth Edition, 1941.

Receiving Antennas:

Effective height:

$$h = V/\epsilon \text{ meters}$$

where V is the open circuit voltage in μv at the antenna terminals induced by the field strength ϵ in μv/m.

Effective height of a loop:

$$h = \frac{2\pi an}{\lambda} \text{ meters}$$

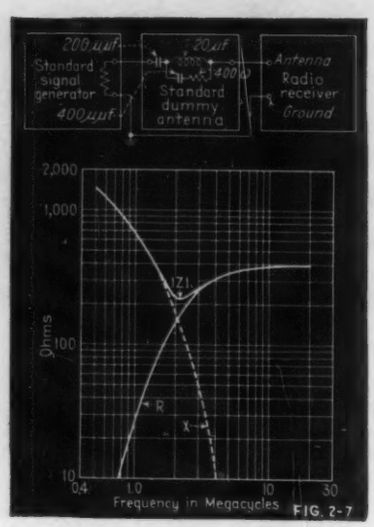


FIG. 2-7

where h is the effective height of the loop when oriented for maximum pickup, a is the area of the loop in square meters, n is the number of turns in the loop, and λ is the operating wavelength in meters.

Effective height of a doublet[2]:

$$h = \frac{L \tan [(\pi L)/(2\lambda)]}{\pi L/\lambda} \text{ meters}$$

where h is the effective height in the direction of maximum response in meters, where L is the physical length in meters, and λ is the operating wavelength in meters.

Example: For a half-wave doublet, $L = \lambda/2$, h is λ/π meters.

The effective height of a doublet short compared with a half wavelength may be taken as half the physical length in meters.

The effective height of a grounded vertical antenna is approximately equal to its length in meters.

Standard Test Antenna[5]:

Figure 2-7 shows the standard dummy antenna and its impedance characteristic. The values used should be within 10% of the nominal values.

R-f amplifiers[1]:

Gain:

See Fig. 2-8. The gain at the maximum point of the resonance curve is given by

$$G = \frac{\mu M/C_s}{r_p R_s + \omega^2 M^2} \text{ times}$$

where μ is the amplification factor of the tube, M the mutual inductance between primary and secondary of the coupling circuit in henries, C_s the secondary tuning capacitance in farads, r_p the internal plate resistance of the tube in ohms, R_s the resistance of the secondary coil in ohms, and $\omega/2\pi$ is the operating frequency in cps.

Optimum gain:

Occurs when the mutual inductance is adjusted to the value

$$M = \frac{\sqrt{r_p R_s}}{2\pi f} \text{ henries}$$

where r_p and R_s (ohms) are shown in Fig. 2-8 and f is the operating frequency in cps.

The gain for optimum coupling is:

$$G = \frac{\mu \omega L_s}{2\sqrt{r_p R_s}} \text{ times}$$

where L_s is the secondary inductance in henries and the other symbols are defined in "Gain," above.

Pentode r-f amplifiers:

The approximate expression for gain in a pentode r-f amplifier, when M is below the optimum value, is

$$G = g_m Q_s \omega M \text{ times}$$

where g_m is the transconductance of the tube, Q_s is the Q-value of the transformer secondary, $\omega/2\pi$ is the operating frequency in cps, and M is the mutual inductance in henries.

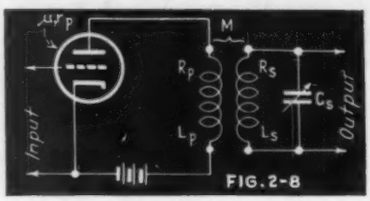


FIG. 2-8

Band-pass r-f amplifier:

The doubly tuned r-f amplifier shown in Fig. 2-9 has a gain given by

$$G = \frac{\mu M}{C_2 \sqrt{\left[A^2 + \omega L_1 R_2 + \frac{A}{\omega L_1 / r_p}\right]^2}}$$

where the symbols (ohms, henries and farads) are given in Fig. 2-9, and $\omega/2\pi$ is the operating frequency and $A = R_1 R_2 + \omega^2 M^2$. This value of gain applies only when primary and secondary are tuned to the same resonant frequency.

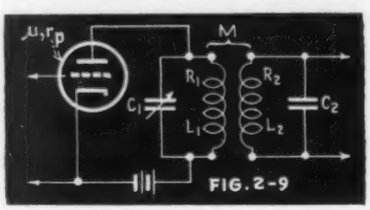


FIG. 2-9

Bandwidth between peaks[6]:

$$\Delta f = \frac{\sqrt{\omega_o^2 M^2 - R_2^2}}{2\pi L_1} \text{ cps}$$

where Δf is the bandwidth between peaks of maximum response under the condition that L_1 and L_2 are equal, and that R_1 and R_2 are equal, $\omega_o/2\pi$ is the center frequency in cps, M is the mutual inductance in henries, L_1 is the primary inductance in henries, and R_1 is the primary resistance in ohms.

The bandwidth to points on the curve exhibiting the same attenuation as at the center frequency (valley) is 41% greater than the bandwidth between peaks of maximum response.

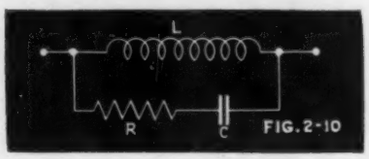


FIG. 2-10

Q Relationships[7]:

If Q is defined as

$$Q = \pi P_t / P_d$$

where P_t is the power transferred from a circuit, P_d the power dissipated in the circuit, both in watts. In the circuit shown in Fig. 2-10 (R ohms, L henries, C farads), the following relationships hold:

$$Q = P_r / P_d$$

where P_r is the reactive volt-amperes circulating in the circuit.

$$Q = \pi/\delta$$

where δ is the decrement $R/(2Lf_o)$.

$$Q = \omega_o L/R$$

where $\omega_o/2\pi = f_o$ is the resonant frequency of the circuit in cps.

$$Q = \frac{\omega_o T_o}{2}$$

where T_o is the time constant $2L/R$ in sec.

$$Q = e_r/e_s$$

where e_r is the voltage in volts developed across the inductance (or across the capacitance) when a series voltage e_s volts is introduced to the circuit, at the resonant frequency.

$$Q = i_r/i_d$$

where i_r is the circulating current in amperes at resonance when the parallel circuit is driven by an external current of i_d amperes.

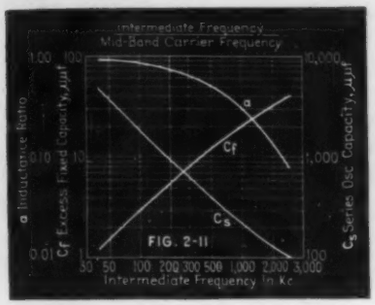


FIG. 2-11

Shunt-series resistance conversion:

To convert the series resistance R shown in Fig. 2-10 to the equivalent shunt resistance R_s,

$$R_s = \frac{L}{CR} \text{ ohms}$$

where L, C and R are the values shown in Fig. 2-10 in henries, farads and ohms, respectively.

Frequency converters:

Conversion conductance:

The approximate value of the conversion conductance of a pentode employed as a frequency converter is one third of the grid-plate transconductance (mutual conductance) of the tube employed as an amplifier.

Conversion gain:

$$G = \frac{g_c r_p R_L}{r_p + R_L} \text{ times}$$

where g_c is the conversion conductance in μmhos, r_p is the internal plate resistance of the tube in megohms, and R_L is the effective series resistance of the load circuit (impedance reflected to primary of first i-f transformer) in megohms.

Trackings:

Figure 2-11 gives the required values of series padder and excess shunt trimmer capacitance C_s and C_f required to produce tracking at three frequencies, in terms of the value of the intermediate frequency, as well as the inductance ratio a between the r-f circuit inductance and the i-f circuit inductance. These values produce theoretically perfect alignment at 600, 1000, and 1400 kc.

Input conductance:

The input conductance of tubes used in frequency conversion is given by

$$g_i = 0.3f + k_A f^2 \text{ μmhos}$$

where f is the operating frequency in Mc, and the values of k_A are given below:

Type	Grid Volts	k_A	Osc. i_c ma; resistance, meg ohms
6A8	−3	−0.05	0.3; 0.05
6J7	−3	0.05	
6K7	−3	0.05	
6K8	−3	−0.08	0.15; 0.05
6L7	−3	0.15	Wide range
6SA7*	0	−0.03	0.5; 0.02
6SA7**	−2	−0.3	0.5; 0.02
6AC7/1852	−2	0.13	
6AB7/1853	−3	0.065	

* Self excited. ** Separately excited.

I-f Amplifiers[3]:

Standard intermediate frequency:

455 kc

For receivers tuning only the broadcast band, values at or near 175 kc are sometimes used.

Gain:

See Fig. 2-12.

$$G = \frac{g_m \omega M}{(R_1 R_2 A + \omega^2 M^2)(\omega^2 C_1 C_2)} \text{ times}$$

where G is the gain with both circuits of the i-f transformer tuned to resonance, g_m is the tube transconductance in μmhos, $\omega/2\pi$ is the i-f frequency in cps, M is the mutual inductance in henries between the circuits, R_1 and R_2 are the primary and secondary series resistances in ohms, A is a factor given below (approximately unity at maximum gain) and C_1 and C_2 are the primary and secondary capacitances in farads.

Example: Gain of several hundred times is possible with tubes having g_m of 1500 μmhos or more. Overall i-f gain ranges from 5,000 (one tube, two transformers) to 30,000 (two tubes, three transformers).

Selectivity Characteristic:

See Fig. 2-12. The selectivity characteristic of an i-f stage is determined

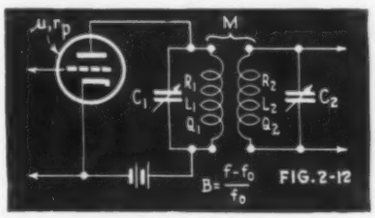


FIG. 2-12

by calculating the gain, as given immediately above, for different values of the factor A, where

$$A = 1 - 4Q_1Q_2B^2 + j(Q_1 + Q_2)B$$

where Q_1 and Q_2 are the Q-values of the primary and secondary of the transformer, and B is the ratio $(f - f_o)/f_o$, where f_o is the resonant frequency and f is any frequency off resonance.

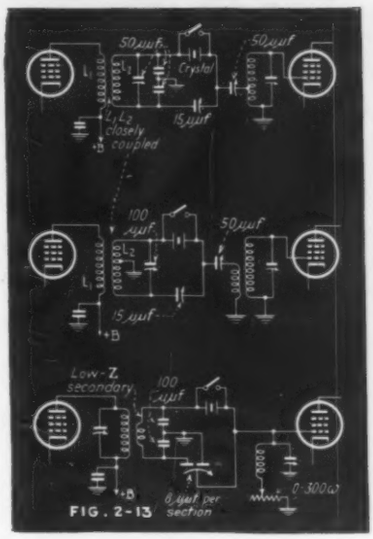


FIG. 2-13

I-f interference:

When the oscillator frequency is higher than the r-f frequency, the image frequency is

$$f_{im} = f_{rf} + 2f_{if} \text{ kc}$$

where f_{rf} is the frequency of the signal at r-f, f_{if} is the i-f frequency, both in kc. When the oscillator frequency is lower than the r-f frequency, the plus sign is replaced by a minus sign.

The oscillator harmonic interference frequencies occur when the r-f signal-frequency circuit is tuned to

$$f_{rf} = nf_o \pm f_{if} \text{ kc}$$

where f_o is the fundamental frequency of the oscillator in kc, n is the order of the harmonic, and f_{if} is the i-f frequency in kc.

The i-f harmonic interference frequencies occur when the r-f signal-frequency circuit is tuned to

$$f_{rf} = nf_{if} \text{ kc}$$

where n is the order of the harmonic and f_{if} is the i-f frequency in kc.

Crystal i-f filters[4]:

Figure 2-13 shows typical crystal filter circuits for increasing i-f selectivity in communications receivers.

Automatic volume control[4]:

Figure 2-14 shows a typical a-v-c circuit.

Detection[3]:

Diode peak detector:

The required RC product in a diode peak detector load circuit is

$$RC \leq \frac{\sqrt{1-m^2}}{2\pi f_m m} \text{ ohm-farads}$$

where R is the value of the load resistance in ohms, C the value of the load by-pass capacitance in farads, m the modulation percentage expressed as a fraction, and f_m the modulation (audio) frequency in cps. *Example:* $f_m = 5000$ cps, $m = 0.8$, RC equal to or less than 0.000024 ohm-farads.

Detection efficiency:

$$e = V_{dc}/V_{rf}$$

where V_{dc} is the d-c output voltage in volts corresponding to the peak input r-f volts V_{rf}.

Internal Diode Resistance:

$$R_d = \frac{E_a - E_d}{I_d} \text{ ohms}$$

where E_a is the peak applied a-c volts, E_d the d-c volts developed across the diode, and I_d is the d-c rectified current in amperes.

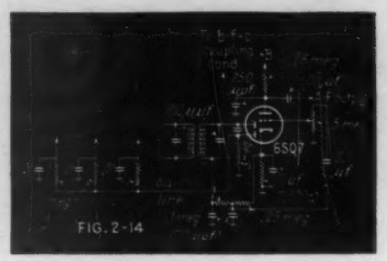


FIG. 2-14

Effective input resistance:

$$R_{in} = \frac{R_L}{2e} \text{ ohms}$$

where R_{in} is the effective input resistance in shunt with the r-f or i-f source, R_L is the detector load impedance in ohms, and e is the detection efficiency expressed as a decimal.

Output impedance:

The output impedance of the diode for modulation frequencies is

$$Z_o = 2nZ_i' \text{ ohms}$$

where n is the detection efficiency expressed as a decimal and Z_i' is the impedance in ohms of the r-f or i-f source at the sideband frequency corresponding to the modulation frequency.

Plate detection resistance:

$$R_d = de_p/di_p \text{ ohms}$$

where the change in plate volts de_p and the change in plate amperes di_p are taken with carrier voltage applied to the grid.

Output voltage of plate detector:

$$E_o = \frac{R_L R_d g_c m E_s}{Z_L + R_d} \text{ volts}$$

where R_L is the load resistance in ohms, R_d the plate detection resistance in ohms, g_c the conversion conductance of the tube as a plate detector in mhos, m the percentage modulation expressed as a fraction, and E_s the r-m-s input r-f volts.

References:

1. Radio Engineering Handbook, 2nd Edition, McGraw-Hill, 1935.
2. Electrical Engineer's Handbook, Volume 5, Wiley, 1936.
3. Radio Engineers Handbook, 3rd Edition, McGraw-Hill, 1941.
4. A.R.R.L. Handbook, 18th Edition, 1941.
5. Standards on Radio Receivers, I.R.E., 1938.
6. Radio Designer's Handbook, R.C.A. (Australia), 1940.
7. Unpublished Notes of W. Hershberger, RCA Manufacturing Company.
8. Landon and Sveen, ELECTRONICS, August 1932.

SECTION 3: FREQUENCY MODULATION

Frequency Allocations:

Educational channels:
42.1, 42.3, 42.5, 42.7, 42.9 Mc.

Commercial channels:
To serve areas greater than 3000 square miles, comprising two or more large cities, or metropolitan districts and rural areas: 43.1, 43.3, 43.5, 43.7, 43.9, 44.1, 44.3 Mc.

Commercial channels:
To serve populations of 25,000 or more, within areas less than 3000 square miles (comprising a metropolitan district, city, or area of one or more towns having common cultural, economic or geographic characteristics):

44.5 Mc	45.5	46.7	47.9
44.7	45.7	46.9	48.1
44.9	45.9	47.1	48.3
45.1	46.1	47.3	48.5
45.3	46.3	47.5	48.7
	46.5	47.7	

Commercial channels:
To serve cities or towns of population less than 25,000 with service area not to exceed 500 square miles: 48.9, 49.1, 49.3, 49.5, 49.7, 49.9 Mc.

Allocation Standards:

Signal strength:
City areas, near factories, car lines, or busy streets: 1 mv/m. Rural areas away from highways: 0.05 mv/m.

Interference:
Objectionable when ratio of desired to undesired signal is less than 10 for 50% of the distance out to the protected contour (same channel). For adjacent channels when the ratio is less than 2.

F.C.C. Transmitter Requirements:

Power:
By the indirect method, the output power is 60% of the product of the total plate current times the plate voltage of the last r-f stage.

Maximum deviation:
Plus or minus 75 kc, for maximum modulation.

Distortion:
Combined a-f harmonics at any frequency from 50 to 15,000 cps, at ±75 kc swing, not more than 2%, r-m-s.

Audio response:
Flat within 2 db of the 1000-cps value from 50 to 15,000 cps.

Pre-emphasis:
Audio frequencies to be pre-emphasised in accordance with the impedance-frequency characteristic of a series RL circuit of 100 μsec time constant.

Noise:
At least 60 db below maximum modulation, in the band 50 to 15,000 cps.

Frequency stability:
Mean frequency to remain within plus or minus 2000 cps of the assigned value. Frequency to be controlled by automatic means not dependent on inductances or capacitances for inherent stability.

Phase-shift Modulator[2]:

(See Fig. 3-1)

Frequency deviation:

$$\Delta f = \frac{2\pi f_m N \phi_i}{360} \text{ cps}$$

where Δf is the deviation from the mean carrier frequency, N is the number of times frequency multiplication following the modulator, and ϕ_i is the phase shift in degrees produced by the modulator prior to frequency multiplication, at the modulating frequency f_m in cps. The maximum allowable ϕ_i is about 30° (see Fig. 3-1).

Required frequency multiplication:

$$N = \frac{360°\Delta f}{2\pi f_m \phi_i} \text{ times}$$

where Δf is the required frequency deviation at carrier frequency, f_m is the modulating frequency, and ϕ_i is the phase shift produced by the modulator prior to multiplication.

Example: $\Delta f = 75{,}000$ cps, $f_m = 60$ cps, $\phi_i = 30°$, $N = 2400$.

Distortion:

(See Fig. 3-1)

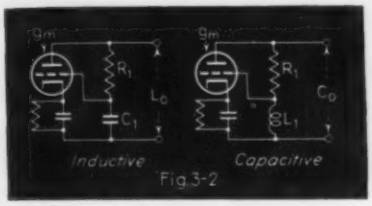


Fig. 3-2

Predistortion:

Figure 3-1 gives a typical network for converting phase modulation to frequency modulation by introducing modulation amplitude inversely proportional to frequency.

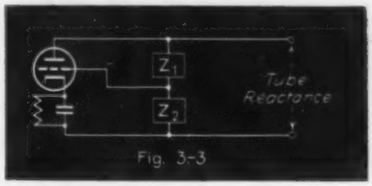


Fig. 3-3

Reactance Tube Modulator[4]

(See Fig. 3-2)

Inductance component:

$$L_e = \frac{C_1 R_1}{g_m} \text{ henries}$$

where L_e is the apparent inductive component between plate and ground, C_1 (farads) and R_1 (ohms) are shown in Fig. 3-2, and g_m is the grid-plate transconductance of the tube in mhos. The variation in inductance L_e depends on the variation in g_m determined by e_g-g_m curve.

Capacitance component:

$$C_e = \frac{L_1 g_m}{R_1} \text{ farads}$$

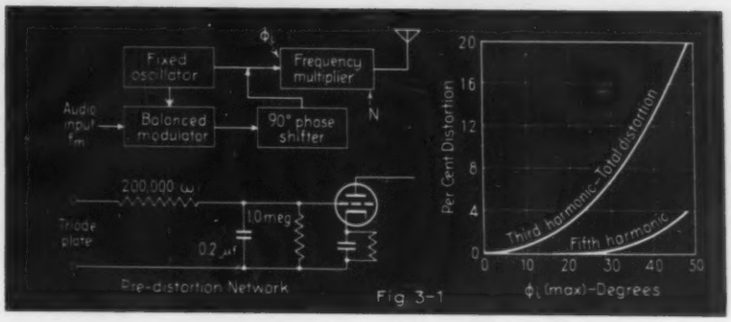


Fig. 3-1

where C_e is the apparent capacitive component between plate and ground, L_1 (henries) and R_1 (ohms) are shown in Fig. 3-2, and g_m is grid-plate transconductance in mhos.

Variation in C_e depends on variations in g_m which can be determined from e_p-g_m curve of tube used.

Example: $g_m = 5000 \mu$mhos, $R_1 = 50{,}000$ ohms, $C_1 = 2\ \mu\mu$f, $L_e = 20\ \mu$h.

Example: $g_m = 5000\ \mu$mhos, $R_1 = 50{,}000$ ohms, $L_1 = 200\ \mu$h, $C_e = 20 \mu\mu$f.

General reactance tube relations:

(See Fig. 3-3)

If Z_1 is resistance and Z_2 is capacitance, the tube reactance is shunt inductance. If Z_1 is resistance and Z_2 inductance, the tube reactance is shunt capacitance. (Z_1 is made at least 5 times Z_2 at frequency of controlled oscillator.)

If Z_1 is resistance and Z_2 is capacitance, the tube reactance is shunt capacitance. If Z_2 is resistance, and Z_1 is inductance, the tube reactance is shunt inductance. (Z_1 is made five times Z_2 at frequency of controlled oscillator.)

Typical reactance-tube modulator design:

Figure 3-4 gives a typical balanced modulator which will produce a frequency deviation of plus or minus 12.5 kc at a carrier frequency of 5 Mc, with 0.6 audio volts r-m-s on grid of each reactance-tube. The use of the balanced reactance-tube circuit minimizes variations in the mean frequency.

Frequency stability:

To stabilize a reactance-tube modulator, use an a-f-c discriminator circuit to compare the mean frequency with a crystal-controlled frequency. Apply voltage developed by discriminator diode in proper polarity to grid of reactance-tube.

Class C R-f Amplifiers for FM

Plate circuit efficiency:

At carrier frequencies 42-50 Mc, passing 200-kc bandwidth: For powers from 30 to 50 kw, 52 to 60%. For lower powers about 60%.

To check bandwidth:

Apply audio modulation at highest audio frequency (15,000 cps) at level for full deviation (±75 kc). No change in plate current of r-f amplifier should be observed when modulating signal is removed.

Measurement of Deviation[5]

Zero method:

The carrier amplitude becomes zero, when the ratio of the deviation to the modulating frequency has any of the following values: 2.40, 5.52, 8.65, 11.79, etc.

Example of method of measurement: Tune unmodulated f-m carrier on communications-type a-m receiver (i-f selectivity in "narrow" position) and set beat oscillator of receiver to pro-

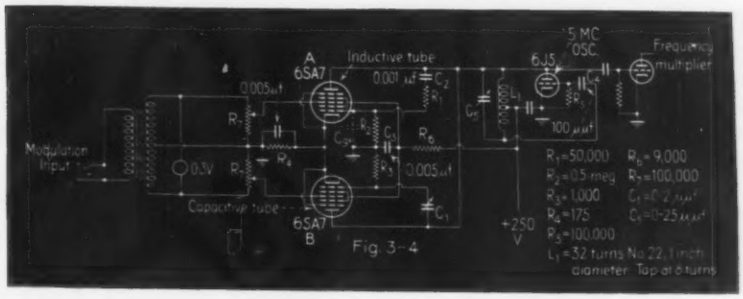


Fig. 3-4

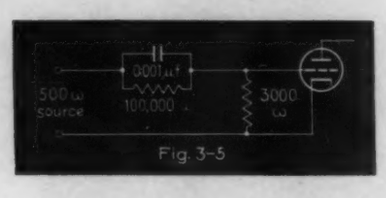


Fig. 3-5

duce a beat note of about 100 cps. Then apply 5000 cps modulating signal and increase level from zero until 100-cps beat note disappears. Deviation is then 2.40 times modulating frequency, or 12 kc. Increase level further until second zero occurs. Deviation is then 5.52 times modulating frequency or 27.6 kc. Deviation at third zero is 8.65 times, or 43 kc; at fourth zero 11.79 times or 59 kc. To check use different modulating frequency, say 10,000 cps (deviation equals 117.9 kc at fourth zero).

At low modulating frequencies, say 50 cps, the sideband spectrum is essentially continuous out to a frequency limit bounded by the frequency swing. Spectrum may be explored with a heterodyne frequency meter.

Measurement of Mean Frequency

In absence of modulation, beat carrier against crystal-controlled frequency of known stability. To measure mean frequency with modulation, use a discriminator, followed by low-pass filter (cutoff at 30 cps). Measure discriminator unbalance with microammeter. Or divide frequency of modulated signal to audio frequency range and compare resulting signal with audio frequency obtained by division from a crystal source.

Measurement of Distortion

Receiver method:

Use high quality f-m receiver, with i-f and discriminator bandpass widened to say 600 kc, for nominal 200 kc channel. Apply modulation and measure distortion with harmonic analyzer. Limit of accuracy is about 0.2 to 0.3 per cent at 1000 cps. Receiver distortion decreases as the modulating frequency decreases. Receiver distortion can be minimized by use of very broad and flat bandpass in i-f and discriminator stages.

Audio Pre-Emphasis

Figure 3-5 shows typical pre-emphasis circuit with time constant of 100 μsec, to operate between 500-ohm source and class-A grid. Circuit should be placed as soon after microphone pre-amplifier as feasible, before studio-transmitter line or radio link.

Receiver Sensitivity

Theoretical limit of usable f-m sensitivity occurs when fluctuation noise in antenna circuit causes saturation of the limiter. For 100-ohm antenna impedance, and 150 kc bandwidth, fluctuation noise is about 1 μv r-m-s, 4.5 μv peak. Gain of 10 million required to saturate limiter requiring 10 volts r-m-s for saturation.

Practical limit of useful sensitivity depends on local noise conditions. F.C.C. marginal service is 50 μv/m, or about 100 μv with 2-meter antenna effective height. Present receivers designed for full limiter action with 10 to 50 μv input.

F-m Converter and Oscillator

Typical converter gain is 18 (g_c of 3000 for 6AC7 tube, and load of 6000 ohms). Oscillator frequency 4.3 Mc above (or below) carrier frequency, about 2 volts peak required. See "Frequency Converter" under Section 4: Television Broadcasting (page 52).

F-m I-f Amplifier

Intermediate frequency:

4.3 Mc is most widely used at present.

Selectivity usually based on 6 db down at plus or minus 75 kc. For receiver used with signals on adjacent channels, above requirement should be met, and in addition 20 db down at plus or minus 100 kc, minimum attenuation. Usual design is two stages prior to limiter, with at least 6 tuned circuits.

Regeneration in i-f stages, including regeneration of i-f harmonics to r-f circuits, causes non-linear distortion.

F-m Limiter

Figure 3-6 shows a typical one-tube pentode limiter. This limiter saturates with input voltage of approximately 10 volts, r-m-s, and has a gain of about unity at the beginning of saturation. The output voltage is roughly 10 volts, r-m-s.

In general, sharp cut-off tubes should be used. The time constants should be short compared with the period of the maximum audio frequency (1/15,000 sec). Low plate and screen voltages contribute plate voltage limiting, while grid-leak produces plate current limiting. High g_m increases the output voltage.

Cascaded (two-tube) limiters have a gain of from 2 to 5 times overall.

In measuring limiter action, apply i-f carrier modulated 50 per cent at voltage level for optimum limiting, and measure percentage modulation in output. Amplitude modulation should be reduced at least 20 to 30 db by limiter action.

Frequency Detector (Discriminator)

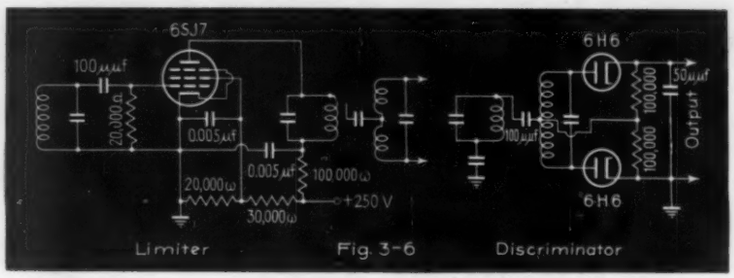


Fig. 3-6

Figure 3-6 shows a typical discriminator circuit. The i-f transformer preceding the diodes is designed conventionally for a bandwidth about one and one-half times the bandwidth of the preceding i-f stages (225 kc wide for nominal 150 kc bandwidth).

Bandwidth of the linear portion of the discriminator characteristic is given by

$$2\Delta f = \frac{f_c}{\sqrt{Q_1 Q_2}}$$

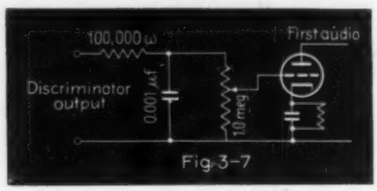


Fig. 3-7

where $2\Delta f$ is the total bandwidth in kc, f_c the mean value of the i-f carrier frequency in kc and Q_1 and Q_2 are the Q-values of the primary and secondary of the discriminator transformer.

The load resistors are chosen to produce linear detection (100,000 ohms each). The load capacitor is chosen to have a reactance at the maximum audio frequency equal to one-half the load resistance.

The output voltage (using a conventional input transformer) is based on developed amplitude modulation not greater than 50%. Hence peak audio output is not greater than 50% of the peak i-f voltage input across the transformer secondary. For low-Q transformers the output may be as low as 25 to 35%.

Audio De-Emphasis

Figure 3-7 shows a typical audio de-emphasis circuit of 100 μsec time constant to operate between discriminator and class A grid. Some adjustment of these values may be necessary for exact compensation.

Sideband Structure in FM

For a single modulating frequency, voltage amplitudes of carrier and sidebands are

$e_c = EJ_0\ (\Delta f/f_m)$ (carrier)

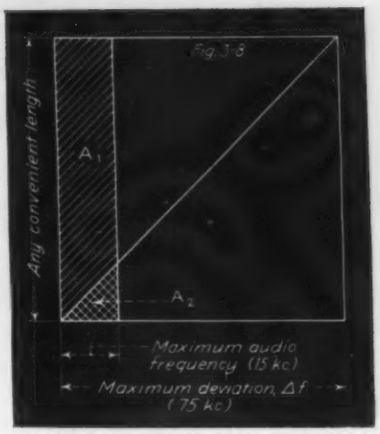
$e_{sb1} = EJ_1\ (\Delta f/f_m)$ (first sideband, adjacent to carrier)

$e_{sbn} = EJ_n(\Delta f/f_m)$ (nth sideband, removed from carrier by n-1 intervening sidebands)

where J_0, J_1 . . . J_n are Bessel functions of zero, first . . . and nth orders, Δf is the frequency deviation in cps, f_m is modulating frequency in cps, and E is the voltage of the f-m signal.

For several simultaneous modulating frequencies, the amplitude is

$$e_c = EJ_0\ (\Delta f_1/f_{m1})\ J_0\ (\Delta f_2/f_{m2}) \ldots J_0\ (\Delta f_n/f_{mn})$$



where e_c is the carrier voltage, E the voltage of the f-m signal, Δf_1, Δf_2 . . . Δf_n are the deviations associated with modulating frequencies f_{m1}, f_{m2} . . . f_{mn} respectively, and J_0 is the Bessel function of zero order.

Noise Relationships[1]

Signal-to-noise ratio: with 75-kc maximum deviation, and standard pre-emphasis, when peak noise is less than one-half the peak r-f signal: 53 db or greater for fluctuation noise, 48 db or greater for impulse noise.

Additional gain in signal-to-noise ratio due to de-emphasis: fluctuation noise 13 db (5.6 in a-m system). Impulse noise 12 db (7.5 db in a-m system).

When noise peak equals or exceeds the peak r-f signal, the noise frequency-modulates the carrier. This type of noise cannot be removed by discriminator or limiter. When impulse noise exceeds the carrier, the signal-to-noise ratio does not go lower than 21 db.

F-m A-m Comparison:

To compare the noise developed in an f-m system with that in a-m system, construct the diagram shown in Fig. 3-8.

For impulse noise, the ratio of a-m noise voltage V_{am} to f-m noise voltage V_{fm} is

$$V_{am}/V_{fm} = A_1/A_2 = 2\Delta f/f_m$$

where Δf is the maximum deviation, f_m is the maximum audio frequency, and A_1 and A_2 are in Figs. 3-8.

For fluctuation noise, the areas A_1' and A_2' must be computed with the ordinates squared. Then the ratio is

$$V_{am}/V_{fm} = \sqrt{A_1'/A_2'} = \sqrt{3}\Delta f/f_m$$

where A_1' and A_2' are the areas found in Fig. 3-8 plotted in squared ordinates, and Δf and f_m are as above.

Definitions

Deviation (Δf):

The displacement of the carrier from its central or mean position. One half of the total frequency excursion.

Deviation ratio: ($\Delta f/f_{max}$)

Ratio of the maximum deviation to the maximum modulating frequency. (*Example:* 75,000/15,000 = 5).

Modulation index:

Ratio of a particular deviation to a particular modulating frequency.

References

1. M. G. Crosby, *RCA Review*, January 1940.
2. D. L. Jaffe, *Proc. I.R.E.*, April 1938.
3. S. W. Seeley, *RCA Review*, April 1941.
4. M. G. Crosby, *RCA Review*, July 1940; *QST*, June 1940.
5. M. G. Crosby, *RCA Review*, April 1940.

SECTION 4: TELEVISION BROADCASTING

Frequency Allocations

Channel Number	Frequency Limits	Channel Number	Frequency Limits
1	50-56 Mc	10	186-192
2	60-66	11	204-210
3	66-72	12	210-216
4	78-84	13	230-236
5	84-90	14	236-242
6	96-102	15	258-264
7	102-108	16	264-270
8	162-168	17	282-288
9	180-186	18	288-294

Allocation Standards

Signal strength:

For built-up city areas, 5 mv/m. For residential and rural areas, 0.5 mv/m.

Interference:

Objectionable when ratio of desired to undesired signal is less than 100 (same channel) or 2 (adjacent channels).

Transmitter Performance Requirements

Frequency stability:

Plus or minus 0.01%, aural and visual. Monitors, plus or minus 0.005%.

Aural Transmitter:

Same as for f-m broadcasting (see page 46).

N.T.S.C. Transmission Standards[1]:

The Television Channel:

See Fig. 4–1.

Scanning Specifications:

525 lines per frame period (n).
30 frames per second (f).
60 fields per second ($2f$).
Aspect ratio 4/3 (w/h).
Active scanning directions: From left to right and top to bottom of the scene.
Note: Symbols refer to equations under Scanning Relations, below.

Picture signal modulation:

Polarity, negative (increase in light causes decrease in carrier amplitude).
Black level, constant at 75% of peak amplitude, ±2.5%, independent of light and shade in the picture. Maximum white level 15% or less of peak carrier amplitude.

Sound signal modulation:

Frequency modulation, maximum deviation ±75 kc. Pre-emphasis as impedance characteristic of RL = 100 μsec.
Radiated power from 50 to 100% of peak power radiated by visual transmitter.

Polarization:

Horizontal.

Synchronizing signal modulation:

Sync waveform and system of modulation must be capable of operating a receiver responsive to waveform in Fig. 4–2.

Interchangeable methods which satisfy this requirement are: (1) Amplitude modulation for picture and sync; (2) A-m picture, f-m sync; (3) F-m picture and sync; (4) A-m picture, f-m/a-m sync.

Tolerances: Timing of horizontal pulses accurate within 0.5 per cent. Frequency variation of horizontal pulses less than 0.15 per cent per second.

Transmitter rating:

Rated power of visual transmitter is peak power when transmitting a standard picture signal.

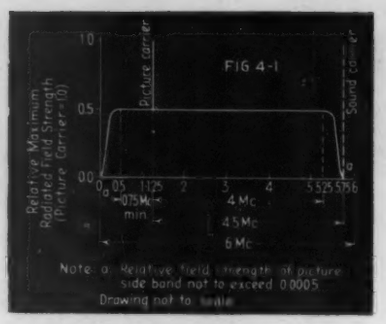
Color Systems

Scanning specifications:

Experimental transmissions: (CBS) 375 lines, 60 frames 120 fields per second; (NBC) 441 lines, 60 frames, 120 fields per second.

Color sequence:

Red, green, blue.



Scanning Relations[2]:

Maximum video frequency:

$$f_{max} = \frac{(w/h)\ kmfn^2\ (r_v/r_h)}{2} \text{ cps}$$

where: w/h is ratio of picture width to height (4/3); k is ratio of vertical resolution to active lines (about 0.8); m is ratio of horizontal to vertical resolution (about unity); f is frame rate (30 per second); n is number of lines (525); r_v is vertical retrace ratio (0.93); and r_h is horizontal retrace ratio (0.86). *Example:* For values given in parentheses f_{max} is 4.8 Mc.

Minimum video frequency:

To reproduce background illumination, 30 cps. To reproduce variations in background, d-c component must change.

Vertical resolution:

$R_v = kr_vn$ elements per picture height.

where symbols are given in "Maximum Video Frequency", above. *Example:* k = 0.8, n = 525, r_v = 0.93, R_v = 390.

Horizontal resolution:

$R_h = 84\ f_{max}$, elements per picture height.

where f_{max} is maximum effective video frequency in Mc. *Example:* f_{max} = 4.2 Mc, R_h = 355. Factor 84 applies to 525-line, 30-frame picture. Factor 100 applies to 441-line, 30-frame picture.

Phase delay:

$$\Delta\phi = 360°f\Delta t \text{ degrees}$$

where $\Delta\phi$ is the phase shift corresponding to time delay Δt sec at frequency f. *Example:* at 4 Mc, 0.1 μsec is 144°.

Echo images:

$$D = \frac{\Delta t}{55} \times 100 \text{ per cent,}$$

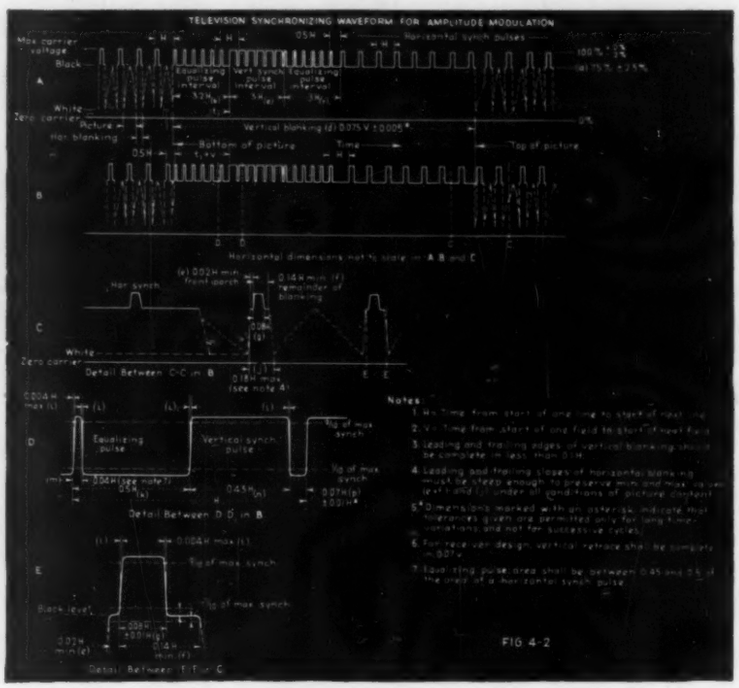
where D is the displacement in per cent of the picture width between two images caused by signals arriving Δt μsec apart. (525-line, 30-frame picture). Waves in free space require 0.00102 μsec per foot of travel.

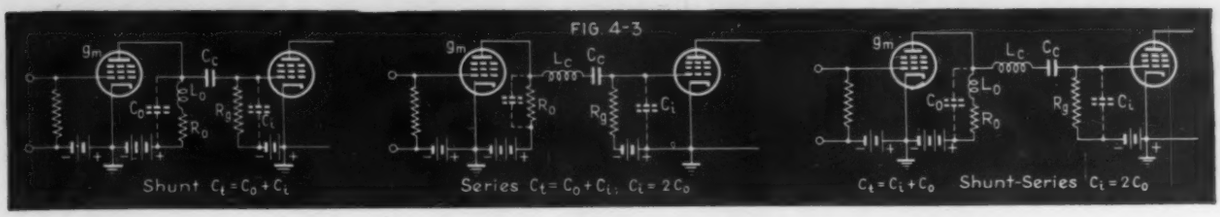
Video Amplifier Design

Stage gain:

$$G = g_m R_v$$

where g_m is transconductance of tube in μmhos and R_v is load resistor in megohms (pentode and tetrode stage only).





Wideband Amplifier Tubes:

See Table I

Compensated Video Amplifiers:

See Table II and Fig. 4-3.

Example of video amplifier design:

$f_{max} = 4$ Mc, $C_t = 35\ \mu\mu f$, $g_m = 8000\ \mu$mhos

R_o (ohms)	L_o (μh)	L_c (μh)	Stage Gain
1150	23	.....	9.2
1715	.....	31	13.8
2080	5.5	24	16.5

Low frequency compensation[4]:

See Fig. 4-4.

$$R_F C_F = R_g C_c$$

($R_F C_F$ = 0.1 or less for stability).

Cathode-coupled amplifier[4]:

See Fig. 4-5.

Gain:

$$G = \frac{\mu R_k}{r_p + R_k(\mu + 1)}$$

Example: $\mu = 6750$, $r_p = 750{,}000$ ohms, $R_k = 1000$ ohms, $G = 0.9$.

Output impedance:

$$Z_o' = \frac{R_k r_p\ (\mu + 1)}{R_k + \dfrac{r_p}{(\mu + 1)}} \text{ ohms}$$

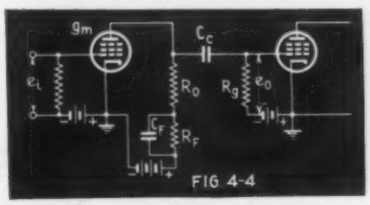
Example: For values given above $Z_o' = 110$ ohms.

TABLE II — VIDEO AMPLIFIER DESIGN[3]

(See Fig. 4-3)

Type of Compensation	R_o (ohms)	L_o (henries)	L_c (henries)	Relative Gain at f_{max}	Variation in time delay (μsec)
None	$\frac{1}{2\pi f_{max} C_t}$	.....	.....	0.707	$0.035/f_{max}$
Shunt	$\frac{1}{2\pi f_{max} C_t}$	$0.5 C_t R_o^2$	.....	1.0	$0.023/f_{max}$
Series	$\frac{1.5}{2\pi f_{max} C_t}$	.....	$0.67 C_t R_o^2$	1.5	$0.011/f_{max}$
Shunt-series	$\frac{1.8}{2\pi f_{max} C_t}$	$0.12 C_t R_o^2$	$0.52 C_t R_o^2$	1.8	$0.015/f_{max}$

Note: f_{max} is the maximum video frequency to be amplified. Other quantities as indicated in Fig. 4-3. For series and shunt-series compensation C_i must equal $2C_o$.



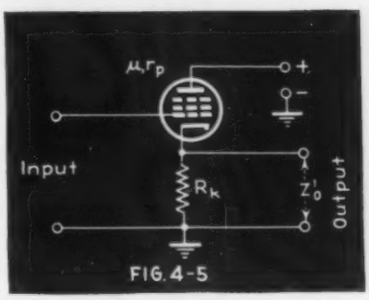


TABLE I — WIDEBAND AMPLIFIER TUBES

Type Number	Type Structure	g_m (μmhos)	μ	C_t* ($\mu\mu f$)	Figure of Merit (g_m/C_t)	Max. Plate Current (ma)
6AB7/1853	R-c-o pentode	5000	3500	13	380	12.5
6AC7/1852	S-c-o pentode	9000	6750	16	550	10
6AG7	Beam tetrode	7700	770	24	320	52
6L6	Beam tetrode	6000	135	26	230	88
6V6	Beam tetrode	4100	218	23	180	45
1231	S-c-o pentode	5500	3850	14	400	10
1232	R-c-o pentode	4000	3000	12	350	12
1851	S-c-o pentode	9000	6750	17	540	10
807	Beam tetrode	6000	135	19	315	100

* C_t is sum of input and output capacitances.

Wideband R-F Circuits[5]

Resistance-loaded tuned circuit:

See Fig. 4-6.

Bandwidth, response down 30 per cent at band edges:

$$2\Delta f = \frac{f_r\sqrt{L/C}}{R} \text{ cps}$$

where $2\Delta f$ is the total bandwidth, f_r is the resonant frequency of L and C, in cps, L/C is the tuned circuit ratio in μh per μf. *Example:* $f_r = 53$ Mc, $L/C = 100$, $R = 100$ ohms, $2\Delta f = 5.3$ Mc.

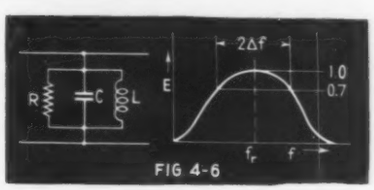
Antenna coupling circuits:

See Fig. 4-7.

Gain at mid-frequency:

$$G = \frac{\sqrt{(1/P^2) - 1 - \Delta\omega/\omega_o}}{\sqrt{2\Delta\omega C r_o}}$$

where $\Delta\omega/2\pi$ is the bandwidth in cps, $\omega_o/2\pi$ is the mid-frequency in cps, r_o internal impedance of the antenna transmission line in ohms, C capacitance of tuned circuit in farads and P the ratio of the



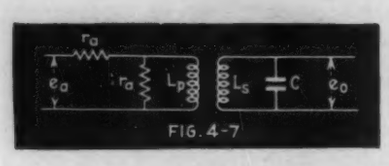


FIG. 4-7

gain at the band-edge to the gain at the center frequency.

Example: $\Delta\omega/2\pi = 4.5$ Mc, $\omega_o/2\pi = 45$ Mc, $p = 0.9$, $r_a = 75$ ohms, $C = 18$ $\mu\mu$f, $G = 2.2$ times.

Wideband r-f amplifier:

See Fig. 4–8.

One tuned circuit: Gain at mid-frequency:

$$G = \frac{g_m\sqrt{(1/P^2) - 1)}}{\Delta\omega C}$$

where g_m is the grid-plate transconductance of the tube in mhos, P is the ratio of band-edge gain to mid-frequency gain, C is the total shunt capacitance in farads and $\Delta\omega/2\pi$ is the bandwidth in cps.

Example: $g_m = 6300$ μmhos, $\Delta\omega/2\pi = 4.5$ Mc, $P = 0.9$, $C = 25$ $\mu\mu$f, $G = 4.25$.

Two tuned circuits, gain at mid-frequency: (Fig. 4–8)

$$G = \frac{g_m}{\Delta\omega\sqrt{C_1C_2}}$$

where g_m is tube transconductance in mhos, $\Delta\omega/2\pi$ is the bandwidth in cps, and C_1, C_2 are the tuned circuit capacitances in farads.

Example: $g_m = 6300$ μmhos, $\Delta\omega/2\pi = 4.5$ Mc, $C_1 = C_2 = 20$ $\mu\mu$f, $G = 11$.

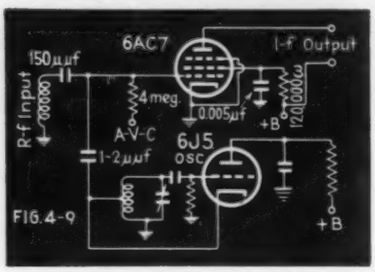


FIG. 4-9

Frequency Converter[6]

A typical frequency converter for television reception is shown in Fig. 4–9. Typical performance: using a 6AC7 pentode, input resistance 2500 ohms, grid circuit noise, for 4 Mc bandwidth, 14 μv minimum. Using a 6AB7 tube, the input resistance is 8000 ohms and the noise 29 μv. Good performance results with peak oscillator voltage of 2 volts or more. The grid current at 60 Mc is about 1 μa.

Wideband I-F Amplifiers

Picture i-f:

12.75 Mc

Sound i-f:

8.25 Mc

Oscillator Frequency:

8 Mc higher than upper frequency limit of channel.

Example: 64 Mc for the 50–56 Mc channel.

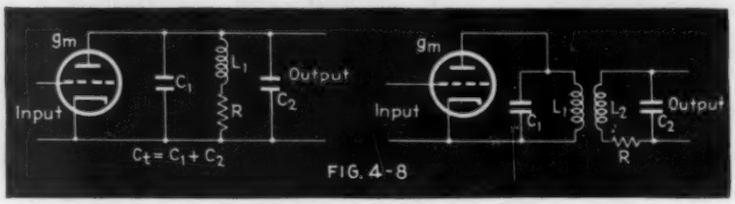


FIG. 4-8

Rejection frequencies:

Associated sound: 8.25 Mc, 40 db attenuation minimum. Adjacent-channel sound: 14.25 Mc, 60 db minimum attenuation.

I-f transformer design[7]:

Figure 4–10 shows design of wideband i-f transformer for 4-Mc bandwidth and mid-frequency of 11.25 Mc. The stage gain is approximately

$$G = \frac{g_mR_p}{2}$$

where g_m is tube conductance in μmhos, and R_p is the load resistance in megohms across the primary of the transformer.

Example: $g_m = 9000$ μmhos, $R_p = 2200$ ohms, $G = 10$.

Video Detection

Typical circuit:

Figure 4–11 shows a constant-K filter load circuit. The capacitance C is kept to a minimum. The peak video output voltage is ordinarily not greater than one half the peak i-f input voltage.

I-f loading:

The loading resistance reflected from the detector to the preceding i-f transformer is

$$R = \frac{R_L}{2n}$$

where R_L is the detector load resistor and n is the detection efficiency.

Definitions:

N.T.S.C. Recommendations:

Television is the electrical transmission and reception of transient visual images.
A **Frame** is a single complete picture.
Scanning is the process of analyzing successively, according to a predetermined method, the light values of picture elements constituting the total picture area.
A **Scanning Line** is a single continuous narrow strip which is determined by the process of scanning.

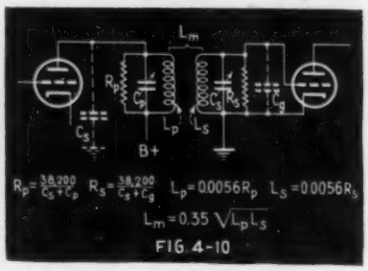


FIG. 4-10

Frame Frequency is the number of times per second the picture area is completely scanned.
The **Aspect Ratio** of a frame is the numerical ratio of the frame width to frame height, as transmitted.
Interlaced Scanning is that in which successively scanned lines are spaced an integral number of line widths, and in which adjacent lines are scanned during successive cycles of the field frequency scanning.
Field Frequency is the number of times per second the frame area is fractionally scanned in interlaced scanning.
Positive Transmission occurs when an increase in initial light intensity causes an increase in the transmitted power.

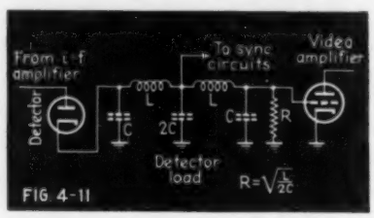


FIG. 4-11

Negative Transmission occurs when a decrease in initial light intensity causes an increase in the transmitted power.

The Video Frequency is the frequency of the signal resulting from television scanning.

The Per Cent Modulation of an amplitude modulated picture transmitter is the reduction, in percentage, from the peak radio frequency output.

Peak Power is the power averaged over a radio frequency cycle corresponding to peak amplitude.

Radiated Power is determined by taking into account both transmitter power and antenna power gain.

D-C Reinsertion

Typical circuits:

Figure 4–12 shows typical d-c reinsertion circuits.

Picture Tubes:

See Table III

Sync Signal Separation

Typical circuits:

Figure 4–13 shows typical sync separation circuits for video-from-sync, and vertical-from-horizontal separation.

Scanning Generators

Typical circuits:

Fig. 4–14 shows typical scanning generator circuits for magnetic vertical and horizontal deflection.

Sync Signal Generation

Frequency division schedule:

For 525-line, 30-frame picture, initial timing frequency is 31,500 cps, followed by four divisions of 7, 5, 5, and 3 to obtain 60 cps for frame timing. Frequency division of 2 gives 15,750 cps for line timing.

Keying tube schedule:

For vertical sync pulse, at beginning of vertical blanking:

1. Key out horizontal pulses for 9.2 H.
2. Key in 6 equalizing pulses for 3.2 H.
3. Key out equalizing pulses for 3 H.
4. Key in 6 serrated pulses for 3 H.
5. Key out serrated pulses.
6. Key in 6 equalizing pulses for 3 H.
7. Key out equalizing pulses.
8. Key in horizontal pulses for remainder of field interval.

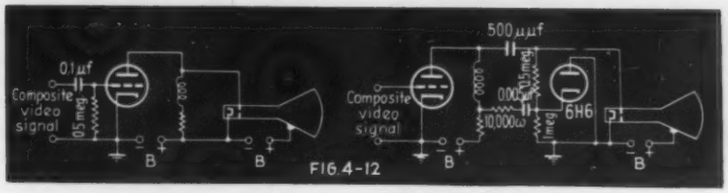
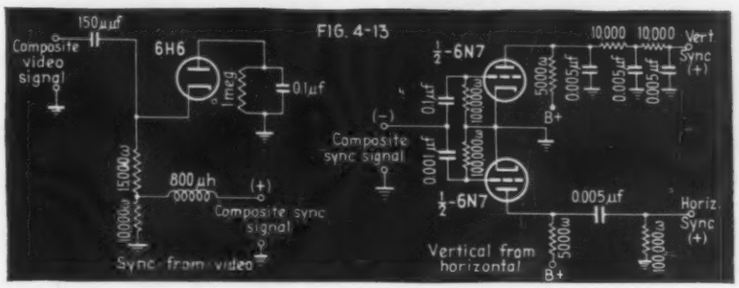


TABLE III — TYPICAL PICTURE TUBES

Type Number	Heater volts/amps	Max. 2nd anode volts	Grid volts pk-pk	Screen diameter inches	Length inches	Base	C_{g_2} μμf	Deflection sensitivity mm/v	Maximum screen mw/cm²
3AP4	2.5/2.1	1500	35	3–1/16	11–7/8	7-AN	9	0.23	10
5AP4	6.3/0.6	2000	35	5–5/16	13–3/8	10-A	9	0.17/0.21	10
5BP4	6.3/0.6	2000	45	5–5/16	17–1/8	10-A	9	0.33	10
7AP4	2.5/2.1	3500	25	7–1/8	13–7/8	5-AJ	12	Magnetic	10
9AP4	2.5/2.1	7000	40	9–1/8	21–3/8	6-AL	12	Magnetic	10
9CP4	2.5/2.1	7000	25	9–1/16	15–3/8	4-AF	12	Magnetic	10
12AP4	2.5/2.1	7000	40	12–3/16	25–3/8	6-AL	12	Magnetic	10
12CP4	2.5/2.1	7000	25	12–1/16	18–1/8	4-AF	12	Magnetic	10



Television Cameras

Output voltage:

$$V = \frac{0.5BKSAR}{f^2} \text{ microvolts}$$

where B is the surface brightness of the scene in candles per square foot, K is the camera tube efficiency, S the photoelectric sensitivity is μa per lumen, A the illuminated area on the camera plate in square feet, R the effective coupling resistance in ohms, and f the numerical aperture (f number) of the lens.

References

1. Report of the National Television System Committee to the F.C.C., March 20, 1941.
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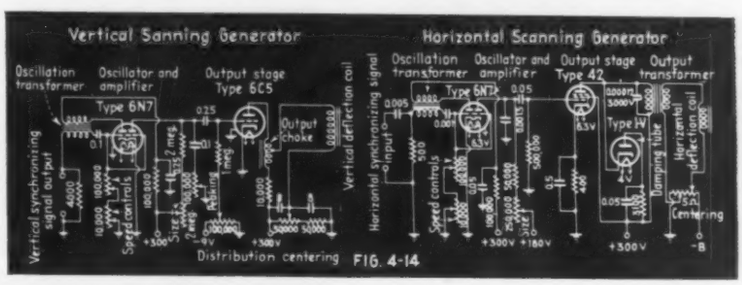
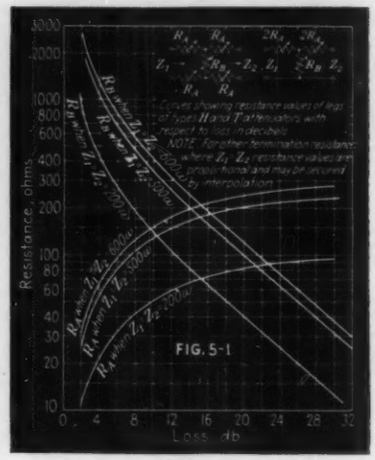
3. Seeley and Kimball, *RCA Review*, October, 1937; January 1939.
4. Preisman, A., *RCA Review*, April 1938
5. Mountjoy, G., *RCA Review*, October 1939.
6. Herold, E. W., *RCA Review*, January, 1940.
7. Wilder and Brustman, ELECTRONICS August, 1940.



SECTION 5: AUDIO AND SOUND SYSTEMS

Resistance Attenuators[9]

Figure 5-1 shows resistance values for the design of H and T attenuators, for 200-, 500- and 600-ohm circuits.
The characteristics of faders for microphone control should include frequency response flat within 1 db from 30 to 15000 cps, and noise level 150 db below maximum level.


Resistance, ohms
Loss, db
Curves showing resistance values of legs of type H and T attenuators with respect to loss in decibels
NOTE: For other termination resistance values, Z_1, Z_2 resistance values are proportional and may be secured by interpolation
FIG. 5-1

Pads[9]

The general expressions for the elements of a T-pad are as follows (See Fig. 5-2)

$$Z_1 = \frac{1 + k^2 - 2k/s}{1 - k^2} \times Z_i \text{ ohms}$$

$$Z_2 = \frac{1 + k^2 - 2k/s}{1 - k^2} \times Z_o \text{ ohms}$$

$$Z_3 = \frac{2k}{1 - k^2} \times sZ_o \text{ ohms}$$

where Z_i is the impedance bridged across the input terminals of the pad (input terminating impedance), Z_o the impedance bridged across the output, both in ohms, k is the voltage ratio corresponding to the number of db loss required, expressed as a fraction, and $s = \sqrt{Z_i/Z_o}$.
The equations apply generally to any form of passive impedance, but are most useful in resistance networks.

π-pads

(See Fig. 5-2) The impedance elements are given by

$$Z_1 = \frac{1 - k^2}{1 - 2ks + k^2} \times Z_i \text{ ohms}$$

$$Z_2 = \frac{1 - k^2}{1 - 2ks + k^2} \times Z_o \text{ ohms}$$

$$Z_3 = \frac{1 - k^2}{2k} \times sZ_o \text{ ohms}$$

where the symbols are defined in "T-pads," above, and shown in Fig. 5-2.

H-pads

$\frac{1}{2}Z_1$ and $\frac{1}{2}Z_2$ are placed in the series arms, where Z_1 and Z_2 are the series resistances calculated for the T-pad, as given above.

Class A Amplifiers

Resistance-Capacitance Coupled

See Fig. 5-3.

Gain, at mid-frequency

$$G = \frac{\mu R_o}{r_p + R_o} \text{ times}$$

where μ is the amplification factor of the tube, R_o is the load resistance in ohms, and r_p is the dynamic internal plate resistance of the tube, in ohms.

For various values of R_o/r_p gain is:

R_o/r_p =	G =
0.5	0.333μ
1.0	0.500μ
2.0	0.666μ
3.0	0.750μ
4.0	0.800μ
5.0	0.833μ
7.0	0.874μ
10.0	0.910μ

Gain, mid-frequency, pentode amplifier

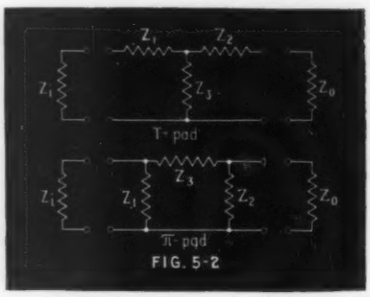
$$G = g_m R_o \text{ times}$$

where g_m is the grid-plate transconductance of the tube in mhos, and R_o is the load resistance in ohms. This equation applies when the dynamic internal plate resistance is large compared with the load resistance.

Gain, low frequency (See Fig. 5-3)

$$G = \frac{g_m (r_p R_o R_g)/(R_p R_g + R_g r_p + R_p r_p)}{\sqrt{1 + \left[\frac{1}{(2\pi f C_c)\,(R_g + (r_p R_o)/(r_p + R_o))}\right]^2}}$$

where the g_m, R and C symbols (mhos, ohms and farads) are shown in Fig. 5-3,



and f is the frequency of operation in cps.
A simplified low-frequency gain equation, assuming R_g and r_p are at least 5 times as great as R_o, is

$$G = \frac{g_m R_o (2\pi f R_g C_c)}{\sqrt{1 + [1/(2\pi f C_c R_g)]^2}} \text{ times}$$

where the symbols are as given in Fig. 5-3, in mhos, ohms, farads and cps.

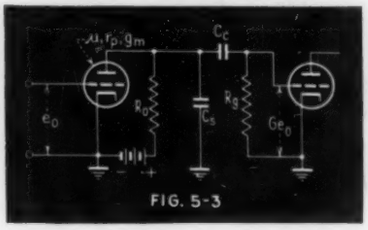
Gain, High frequency

$$G = \frac{g_m R_o}{\sqrt{1 + (2\pi f C_s R_o)^2}}$$

where the symbols (mhos, ohms, farads and cps) are as shown in Fig. 5-3, C_s is the total shunt capacitance in the coupling circuit, f the frequency of operation, g_m the tube transconductance, and R_o is

$$R_o = (r_p R_o R_g)/(R_p R_g + R_g r_p + R_p r_p)$$

A simplified high-frequency gain equation, assuming R_g and r_p are at least five times R_o, is



$$G = \frac{g_m R_o}{\sqrt{1 + (2\pi f C_s R_o)}}$$

where the symbols (mhos, ohms, farads and cps) are given in Fig. 5-3.

RC Coupled Amplifier Chart

The table on page 55 shows typical design data for resistance-capacitance coupled amplifiers, the gain being that in the mid-frequency region.

Power Relationships—Class A[10]

Plate dissipation

$$P_p = I_b E_b \text{ watts}$$

where I_b is the d-c value of plate current in amperes, and E_b is the d-c value of plate voltage (plate to cathode) in volts.

Maximum power output, triode

$$P_o = \frac{\mu^2 E_g^2}{4 r_p} \text{ watts}$$

where μ is the amplification factor of the

tube, E_g the r-m-s input grid volts, and r_p is the internal dynamic plate resistance of the tube in ohms. Maximum power output occurs when the load resistance $R_o = r_p$.

Maximum undistorted power output, triode

$$P_o = \frac{\mu^2 E_g^2}{9 r_p} \text{ watts}$$

where the symbols have the same meaning as in "Maximum Power Output" above. Maximum undistorted power output occurs when the load resistance $R_o = 2r_p$.

Power sensitivity, triode

$$S_p = \frac{\mu^2 R_o}{(R_o + r_p)^2} \text{ watts/volt}$$

where S_p is the output power per r-m-s grid volt, μ the amplification factor, R_o the load resistance in ohms, and r_p the dynamic tube plate resistance in ohms.

Power output, triode[5]

$$P_o = \frac{(I_{max} - I_{min})(E_{max} - E_{min})}{8} \text{ watts}$$

where the currents and voltages (amperes and volts) are the instantaneous maximum and minimum values attained in the cycle.

Percent Distortion[5]

$$D_2 = \frac{\frac{(I_{max} - I_{min})}{2} - I_o}{I_{max} - I_{min}} \times 100 \text{ per cent}$$

where D_2 is the percentage second harmonic distortion, I_{max} and I_{min} are the maximum and minimum instantaneous values of plate current in amperes, and I_o is the zero-signal plate current in amperes.

Push-pull power output, triodes[5]

$$P_o = \frac{I_{max} E_b}{5} \text{ watts}$$

where P_o is the maximum undistorted output power for two tubes, I_{max} is the maximum instantaneous value of plate current in amperes, and E_b is the applied plate voltage in volts.

Zero Signal Bias, triode[5]

$$E_c = -\frac{0.68\, E_b}{\mu} \text{ volts}$$

where E_c is the desirable value of zero-signal bias, for a tube of amplification factor μ and applied plate voltage E_b volts.

Load resistance, triode

$$R_o = \frac{E_{max} - E_{min}}{I_{max} - I_{min}} \text{ ohms}$$

RESISTANCE-COUPLED AMPLIFIER CHART

Condensed from RCA Tube Handbook HB-3

C = blocking condenser in μf
C_c = cathode by-pass condenser in μf
C_d = screen by-pass condenser in μf
E_{bb} = plate-supply voltage in volts
E_o = voltage output in peak volts
R_c = cathode resistor in ohms
R_d = screen resistor in megohms
R_g = grid resistor in megohms for following stage
R_L = plate resistor in megohms
$V.G.$ = voltage gain at 5v r-m-s output

6F8-G (one triode unit), 6J5, 6J5-G, 6J5-GT, 12J5-GT:

E_{bb}	90			180				300		
R_L	0.05	0.1	0.25	0.05	0.1		0.25	0.05	0.1	0.25
R_g	0.1	0.25	0.5	0.1	0.1	0.25	0.5	0.5	0.1	0.25	0.5
R_c	2,070	3,940	9,760	1,490	2,330	2,830	3,230	7,000	1,270	2,440	5,770
C_c	2.66	1.29	0.55	2,86	2.19	1.35	1.15	0.62	2.96	1.42	0.64
C	0.029	0.012	0.007	0.032	0.038	0.012	0.006	0.007	0.034	0.0125	0.0075
E_o	14	17	18	30	26	34	38	36	51	56	57
$V.G.$	12	13	13	13	14	14	14	14	14	14	14

6SF5, 12SF5, 6F5, 6F5-G, 6F5-GT, 12F5-GT:

E_{bb}	90			180				300		
R_L	0.1	0.25	0.5	0.1	0.25		0.5	0.1	0.25	0.5
R_g	0.25	0.5	1	0.25	0.25	0.5	1	1	0.25	0.5	1
R_c	4,800	8,800	13,500	2,000	3,500	4,100	4,500	6,900	1,600	3,200	5,400
C_c	2.1	1.18	0.67	3.3	2.3	1.8	1.7	0.9	3.7	2.1	1.2
C	0.01	0.005	0.003	0.015	0.01	0.006	0.004	0.003	0.01	0.007	0.004
E_o	5	7	10	23	21	26	32	33	43	54	62
$V.G.$	34[b]	43[c]	46	44	48	53	57	63	49	63	70

6J7, 6J7-G, 6J7-GT, 6W7-G, 12J7-GT, 6C6, 57:

E_{bb}	90			180				300		
R_L	0.1	0.25	0.5	0.1	0.25		0.5	0.1	0.25	0.5
R_g	0.25	0.5	1	0.25	0.25	0.5	1	1	0.25	0.5	1
R_d	0.44	1.18	2.6	0.5	1.1	1.18	1.4	2.9	0.5	1.18	2.9
R_c	1,100	2,600	5,500	750	1,200	1,600	2,000	3,100	450	1,200	2,200
C_d	0.05	0.03	0.05	0.05	0.04	0.04	0.04	0.025	0.07	0.04	0.04
C_c	5.3	3.2	2	6.7	5.2	4.3	3.8	2.5	8.3	5.4	4.1
C	0.01	0.005	0.0025	0.01	0.008	0.005	0.0035	0.0025	0.01	0.005	0.003
E_o	22	32	29	52	41	60	60	56	81	104	97
$V.G.$	55	85	120	69	93	118	140	165	82	140	350

[b] At 3 volts r-m-s output. [c] At 4 volts r-m-s output.

Power Output—Pentodes and Tetrodes

$$P_o = \frac{[I_{max} - I_{min} + 1.4\,(I_o - I_b)]^2 R_o}{32} \text{ watts}$$

where I_{max} and I_{min} are the maximum and minimum values of plate current, in amperes, I_o and I_b are the plate currents in amperes corresponding respectively to 0.3 and 1.7 times the zero signal bias, and R_o is the load resistance in ohms.

Distortion; Pentodes and Tetrodes

$$D_3 = \frac{I_{max} - I_{min} - 1.4\,(I_o - I_b)}{I_{max} - I_{min} + 1.4\,(I_o - I_b)} \times 100 \text{ per cent}$$

$$D_2 = \frac{I_{max} + I_{min} - 2I_o}{I_{max} - I_{min} + 1.4\,(I_o - I_b)} \times 100 \text{ per cent}$$

where D_2 and D_3 are the second and third harmonic distortions, I_o is the zero-signal plate current and the other symbols are defined under "Power Output-Pentodes and Tetrodes," above.

Pentode load resistance

$$R_o = k r_p \text{ ohms}$$

where R_o is the load resistance representing a compromise between maximum power output and minimum distortion, r_p is the tube internal plate resistance in ohms, and k as a factor varying between 0.15 and 0.25.

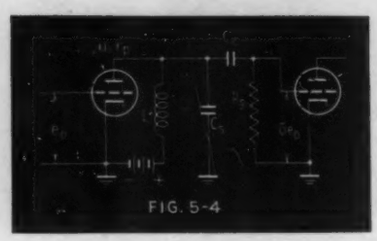


FIG. 5-4

Impedance Coupled Amplifier[10]

See Fig. 5-4.

Gain, mid-frequency

$$G = \frac{\mu R_g}{r_p + R_g} \text{ times}$$

where R_g is the grid resistor of the following tube in ohms, μ and r_p are the amplification factor and plate resistance in ohms of the tube.

Gain, low-frequency

$$G = G_{mf} \times \frac{1}{\sqrt{1+\left[\frac{r_p R_c}{2\pi f L\,(r_p+R_c)}\right]^2}} \text{ times}$$

where G is the gain (above 50 cps, when C_c is 0.05 μf or greater, and R_g 0.5 megohm or greater) G_{mf} is the mid-frequency gain (see above), L is the coupling inductance in henries, f is the operating frequency in cps, and the other symbols are defined in "Gain mid-frequency," above.

Gain, high-frequency

$$G = G_{mf} \times \frac{1}{\sqrt{1+\left[\frac{2\pi f C_s R_g r_p}{r_p+R_g}\right]^2}} \text{ times}$$

where G_{mf} is the mid-frequency gain (see above), f the operating frequency in cps, C_s the total shunt capacitance of the stage in farads, and other symbols are defined in "Gain, mid-frequency," above. This equation assumes negligible core loss in the choke.

Transformer Coupled Amplifiers[10]

See Fig. 5-5.

Equivalent circuit

The equivalent circuit of a transformer coupled amplifier is shown in Fig. 5-5, where the symbols are as follows:
r_p is the dynamic plate resistance, R_p primary winding resistance, R_c core-loss resistance (all in ohms), L_m magnetizing inductance, L_1 and L_2 primary and secondary fictitious inductances such that the turns ratio $N = \sqrt{L_2/L_1}$ is the ratio of secondary turns to primary turns, L_p and L_s the primary and secondary leakage inductances (all in henries), and C_s is the following

$$C_s = (C_m + C_c + C_L)\,N^2 \text{ farads}$$

where C_m is the mutual capacitance between windings, C_c the secondary distributed capacitance, and C_L is the tube input capacitance of the following stage (all in farads).

Gain, mid-frequency

$$G = \mu N \text{ times}$$

where μ is the amplification factor of the tube and N is the ratio of the secondary turns to the primary turns in the coupling transformer.

Gain, low-frequency

$$G = G_{mf} \times \frac{1}{\sqrt{1+\left[\frac{(R_p+r_p)R_c}{2\pi f L_m (R_c+R_p+r_p)}\right]^2}}$$

where f is the frequency of operation in cps and the other symbols are defined in "Equivalent Circuit," above, and shown in Fig. 5-5. G_{mf} is the mid-frequency gain (see above).

Gain, high-frequency

$$G = G_{mf} \times \frac{1}{\sqrt{\left[1-\frac{f^2}{f_r^2}\right]+\frac{f^2}{f_r^2 Q_r^2}}}$$

where f is the frequency of operation in cps, f_r is $1/(2\pi\sqrt{L_t C_s})$ in cps, Q_r is $2\pi f_r L_t / R_r$. $L_t = L_p + L_s/N^2$ henries, $R_r = r_p + R_p + R_c/N^2$ ohms. L_p, L_s, N, C_s, r_p, R_p, R_c are defined in "Equivalent Circuit," above, and shown in Fig. 5-5.

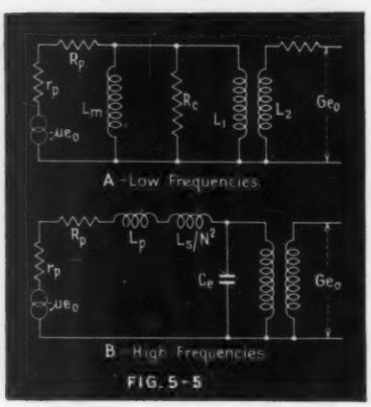


FIG. 5-5

Transformer Design

Magnetizing inductance

$$L_m = \frac{4\pi 10^{-9} N_p^2 \mu_r A}{l} \text{ henries}$$

where N_p is the number of turns in the primary, μ_r the relative permeability, A the net area of the core section in square cm, and l the mean core length in cm.

Core-loss resistance

$$R_c = \frac{2\pi^2 10^{-16} f^2 N_p^2 A}{K_c l} \text{ ohms}$$

where f is the frequency of operation in cps, K_c is the ratio of the core loss in watts per cc per gauss^2, and the other symbols are defined in "Magnetizing Inductance," above.

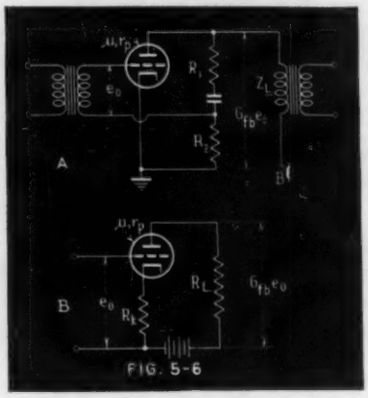


FIG. 5-6

Degenerative Feedback[7]

Circuits

Two feedback circuits are shown in Fig. 5-6.

Gain without feedback

$$G = \frac{\mu Z_L}{r_p + Z_L}$$

where μ is the amplification factor, Z_L is the plate load impedance, and r_p is the dynamic plate resistance of the tube, both in ohms.

Gain with feedback

$$G_{fb} = \frac{G}{1 + G\beta}$$

where G is the gain without feedback (see above), and β is the feedback factor defined below.

Feedback factor

In the basic circuit (Fig. 5-6A).

$$\beta = \frac{R_2}{R_1 + R_2}$$

where R_1 and R_2 are the plate circuit feedback resistors in ohms.

Feedback design basic circuit[7]

Figure 5-7 gives the amount of feedback in db (feedback = $1 + G\beta$) for various values of G and β for the circuit shown in Fig. 5-6A.

Example: G = 10,000 (80 db), feedback = 30 db, G_{fb} = 50 db, β = 0.003, R_1 = 332 R_2.

Cathode-resistance feedback

In Fig. 5-6B, the feedback factor is

$$\beta = \frac{R_k}{Z_L}$$

The gain in the absence of feedback is given by

$$G = \frac{\mu Z_L}{r_p + Z_L + R_k}$$

Filters[10]

m-derived. L-sections

See Fig. 5-8. R is the characteristic impedance in ohms (nominal terminal resistance) and f_c is the cut-off frequency in cps, and m is a design factor ranging from 0.1 (sharp cutoff) to 1.0 (slow cutoff, constant-K type)

Low-pass

$$L_1 = \frac{mR}{\pi f_c} \text{ henries}$$

$$L_2 = \frac{(1 - m^2)R}{4m\pi f_c} \text{ henries}$$

$$C = \frac{m}{\pi f_c R} \text{ farads}$$

High-pass

$$L = \frac{R}{4\pi f_c m} \text{ henries}$$

$$C_1 = \frac{1}{4\pi f_c m R} \text{ farads}$$

$$C_2 = \frac{m}{(1 - m^2)\pi f_c R} \text{ farads}$$

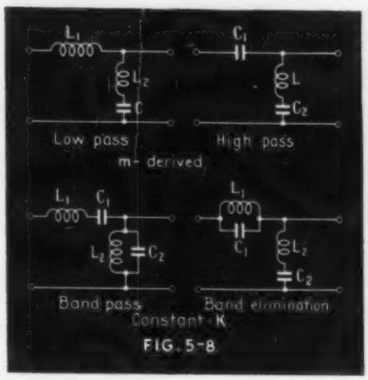


FIG. 5-8

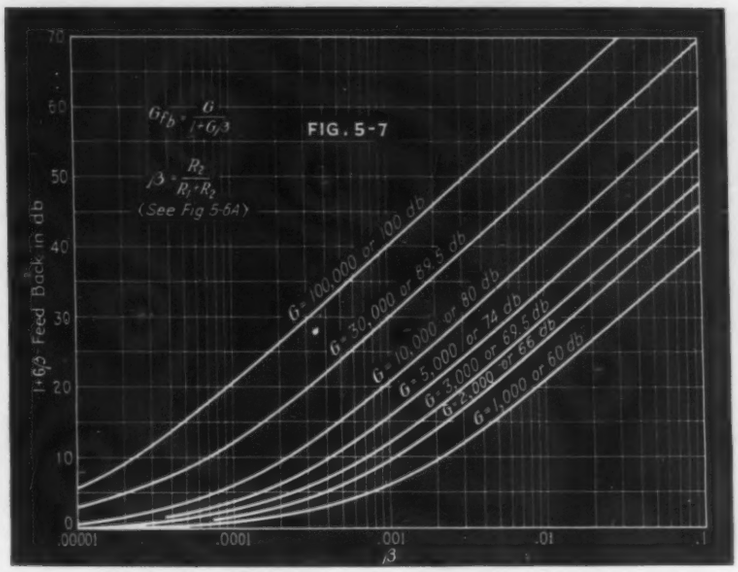


FIG. 5-7
$G_{fb} = \frac{G}{1+G\beta}$
$\beta = \frac{R_2}{R_1+R_2}$
(See Fig 5-6A)
1+Gβ Feed Back in db
G = 100,000 or 100 db
G = 30,000 or 89.5 db
G = 10,000 or 80 db
G = 5,000 or 74 db
G = 3,000 or 69.5 db
G = 2,000 or 66 db
G = 1,000 or 60 db
β

Note: C_2 is replaced by a short circuit in constant-K (m = 1) high-pass filter.

Constant-K L-sections

See Fig. 5-8. R is the characteristic impedance (nominal terminal resistance) in ohms, f_{c1} the low-frequency cut-off frequency and f_{c2} the high frequency cut-off frequency, both in cps.

Band-pass

$$L_1 = \frac{R}{\pi(f_{c2} - f_{c1})} \text{ henries}$$

$$L_2 = \frac{(f_{c2} - f_{c1})R}{4\pi f_{c2} f_{c1}} \text{ henries}$$

$$C_1 = \frac{(f_{c2} - f_{c1})}{4\pi f_{c2} f_{c1} R} \text{ farads}$$

$$C_2 = \frac{1}{\pi(f_{c2} - f_{c1})R} \text{ farads}$$

Band-elimination

$$L_1 = \frac{(f_{c2} - f_{c1})R}{\pi f_{c2} f_{c1}} \text{ henries}$$

$$L_2 = \frac{R}{4\pi(f_{c2} - f_{c1})} \text{ henries}$$

$$C_1 = \frac{1}{4\pi(f_{c2} - f_{c1})R} \text{ farads}$$

$$C_2 = \frac{f_{c2} - f_{c1}}{\pi R f_{c2} f_{c1}} \text{ farads}$$

Recurrent filters

T-section and π-section filters are formed from L-section filters as shown in Fig. 5-9 where Z_1 is the series arm of the L-section and Z_2 is the shunt arm of the L-section.

Class B Amplifiers[4]:

Power output

$$P_o = \frac{I_{max}^2 R_o}{2} \text{ watts}$$

where P_o is the power output for two tubes, I_{max} is the maximum instantaneous value of plate current in amperes attained during the cycle and R_o the load resistance in ohms.

Plate dissipation

$$P_p = \frac{0.637\, I_{max} E_b - 0.5\, I_{max}^2 R_o}{2} \text{ watts}$$

where P_p is the plate dissipation per tube, I_{max} is the maximum instantaneous

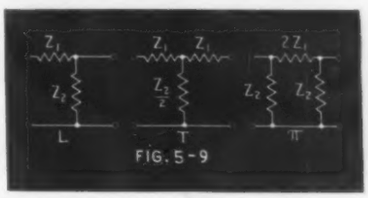


FIG. 5-9

value of plate current in amperes, E_b is the applied plate voltage in volts, R_o the load resistance in ohms.

Plate efficiency

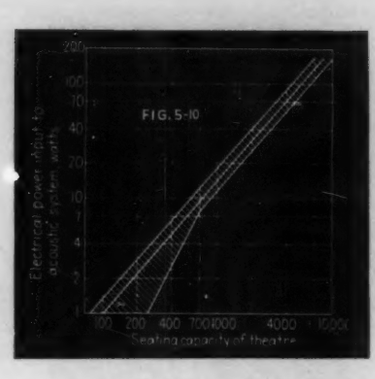
$$n = \frac{I_{max} R_o}{1.27 E_b} \times 100 \text{ per cent}$$

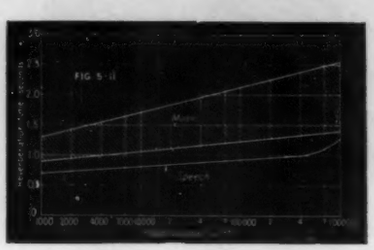
where the symbols are defined in "Plate dissipation" above.

Load resistance

$$R_o = R_e / 4 \text{ ohms}$$

where R_e is the effective load resistance





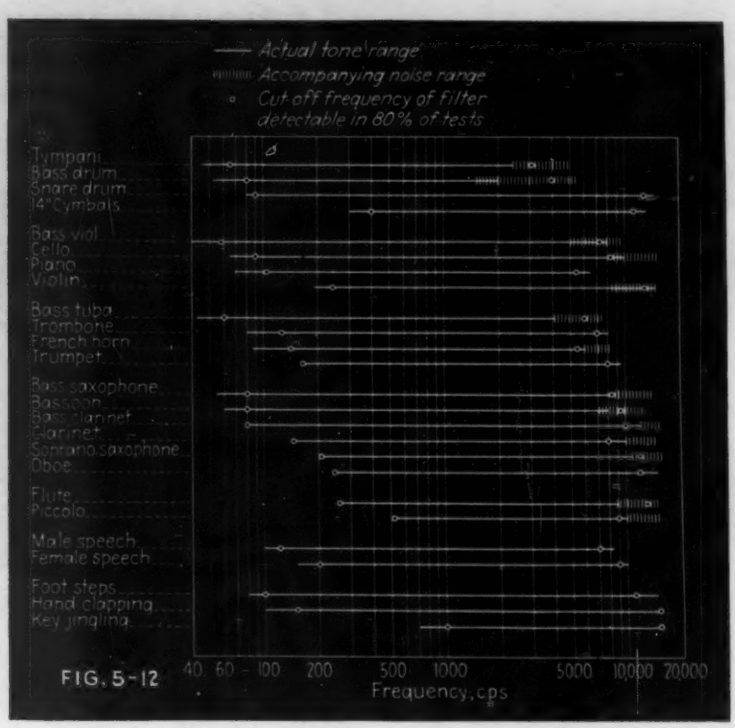


FIG. 5-12

used in the expression given above, and R_t is the effective plate-to-plate resistance presented by the primary terminals of the output transformer.

Loudspeaker Acoustics[4]

Exponential horn design

$$S = S_o e^{Tx} \text{ square cm}$$

where S is the area in sq cm of a section of the horn at a distance x cm from the throat, S_o is the area of the section at the throat in sq cm, T is a taper constant determined from the cut-off frequency (see below) and ϵ is 2.718

Cut-off frequency

$$f_c = \frac{Tc}{4\pi} \text{ cps}$$

where T is the taper factor for the horn design (see above), and c is the velocity of sound in air (about 34,500 cm per sec.)

Required Power[9]

Figure 5–10 shows the required electrical output in watts required for satisfactory coverage of a theatre or hall.

Reverberation time

$$t = \frac{0.05V}{Sa} \text{ seconds}$$

where t is the time in seconds required for the sound energy to drop 60 db after source is shut off, V is the volume of the room in cubic feet, S is the area of the walls in square feet, and a is the average absorption coefficient of the walls (1.0 for open window, roughly 0.02–0.07 for brick wall, 0.2 for celotex, 0.5 for rock wool.)

The optimum reverberation times for different types of sound and room size are shown in Fig. 5–11.

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1. Olson and Massa, Applied Acoustics, Blakiston, 1940.
2. A.R.R.L. Handbook, 18th Edition, 1941.
3. Radio Engineering Handbook, 2nd Edition, McGraw-Hill, 1936.
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5. RCA Receiving Tube Manual, RC-14.
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7. Unpublished notes, L. S. Biberman, RCA Manufacturing Co.
8. Reich, Theory and Applications of Electron Tubes, McGraw-Hill, 1939.
9. Motion Picture Sound Engineering, Van Nostrand, 1938.
10. Radio Engineering Handbook, 3rd Edition, McGraw-Hill, 1941.

Section 6: Industrial and Power Applications

Power-Supply Rectifiers

Characteristics of high-vacuum rectifiers[1]

Figure 6-1 gives typical voltage-drop vs. current-drain characteristics of several receiving type high-vacuum rectifiers.

Rectifier-resistance load[2]

When a half-wave rectifier works directly into a resistance load, without any intervening filter circuit, the average current passed through the load is

$$I_{av} = \frac{0.45\,(V_{rms}) - V_{drop}}{R_L} \text{ amperes}$$

where V_{rms} is the r-m-s a-c volts across the power transformer secondary terminals, V_{drop} is the drop across the rectifier in volts, for the average current passing through the tube, and R_L is the load resistance in ohms. Note: V_{drop} is determined from Fig. 6-1 for the average current output.

This equation applies also the mer-

cury-vapor rectifiers. In this case the value of V_{drop} is about 15 volts, and is independent of the load current.

In full-wave circuits, the average current is twice that given by the half-wave equation, above, using V_{rms} as the r-m-s a-c voltage between the center-tap and one terminal of the power transformer secondary.

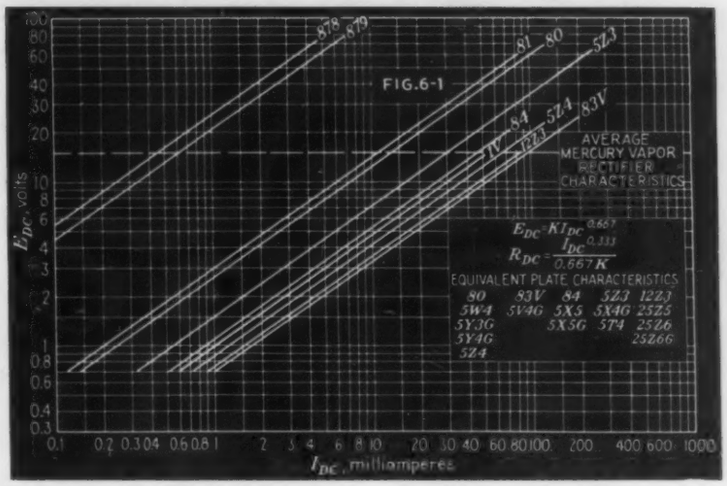
Average load voltage

$$V_{av} = I_{av} R_L \text{ volts}$$

where the symbols are given above.

Rectifier circuit relationships

Table I shows the voltage, current and power relationships of single-phase and multiphase rectifier circuits (see Fig. 6-2).



High-Frequency Power[6]

Design of h-f oscillator

Equivalent load resistance across tank

$$R_L = \frac{1.3\,E_b^2}{P_o} \text{ ohms}$$

where E_b is the plate supply voltage in volts, and P_o is the required output power in watts.

Circulating reactive power

For good design, the circulating reactive power in the tank circuit should be at least 20 times the output power:

$$P_r = 20\,P_o \text{ volt-amperes}$$

Tank circuit design

The value of the capacitor of the tank circuit is determined by

$$C = \frac{20}{2\pi f R} \text{ farads}$$

where C is the tank circuit capacitance required for a circulating reactive power 20 times the output power, f is the frequency of oscillation in cps, and R is the equivalent load resistance across the tank (see above) in ohms.

Tank inductance

$$L = \frac{1}{(2\pi f)^2 C} \text{ henries}$$

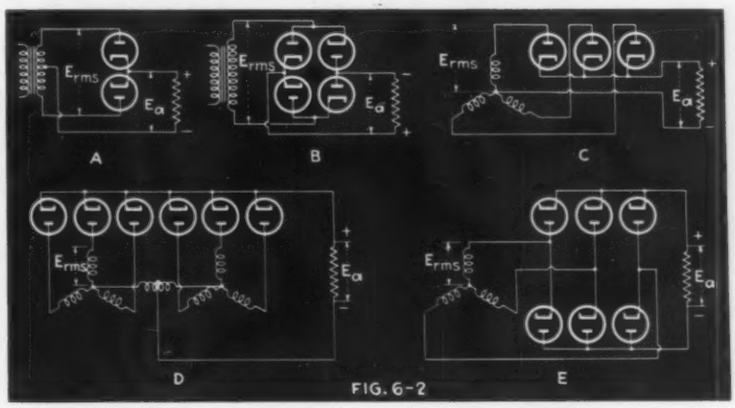
where f is the oscillation frequency in cps and C is the tank capacitance (see above) in farads.

Example: for 500 watts output power at 10,000 cps, $R = 12{,}500$ ohms, $C = 0.0265$ μf, and $L = 9.6$ millihenries. The tank inductance consists of 294 turns on a form 12 inches in diameter, 24 inches long.

TABLE I—RECTIFIER CIRCUITS[2] (See Fig. 6-2)

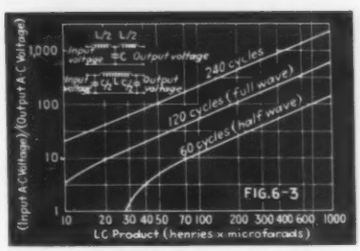
	Circuit A	Circuit B	Circuit C	Circuit D	Circuit E
Average Load.....	0.45 E_{rms}	0.90 E_{rms}	1.07 E_{rms}	1.07E_{rms}	2.32 E_{rms}
(Volts)	0.32 E_{max}	0.64 E_{max}	0.83 E_{max}	0.83 E_{max}	1.65 E_{max}
Peak Inverse.....					
(Volts)	3.14 E_a	1.57 E_a	2.09 E_a	2.09 E_a	1.05 E_a
Secondary kva*....	1.57	1.11	1.48	1.48	1.05
Primary kva*.....	1.11	1.11	1.21	1.05	1.05
R-m-s ripple.....	48%	48%	18%	4%	4%

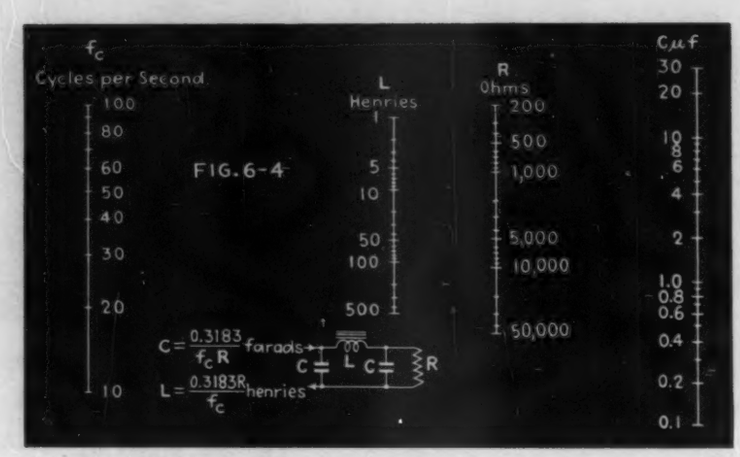
Note: Drop through rectifier tubes neglected.
*** Per kw power delivered to load, transformer losses neglected.**



Power Supply Filters[4]

Figure 6-3 shows the reduction in ripple (input a-c volts per output a-c volt) for a single T-section or π-section filter in terms of the *LC* product in the filter.





Per cent ripple, single-section filter[2]

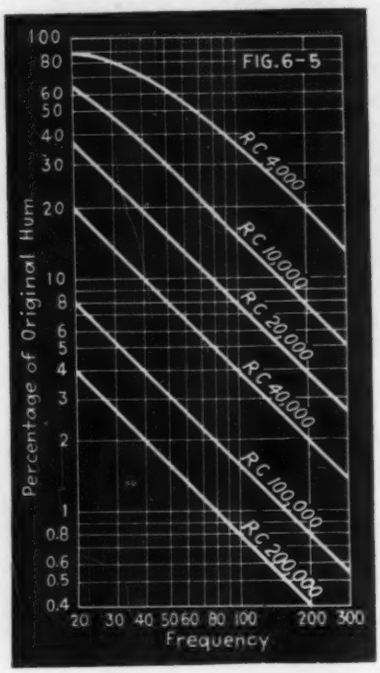
$$R_1 = \frac{mX_C}{X_L - X_C} \times 100 \text{ per cent}$$

where m is 0.7 for single-phase full-wave, 0.24 for three-phase half-wave, 0.05 for six-phase half-wave rectifier; X_C is the reactance in ohms of the capacitor at the ripple frequency (supply frequency times number of phases), and X_L is the reactance in ohms of the inductor at the ripple frequency.

Per cent ripple, double-section filter[2]

$$R_2 = R_1 \times \frac{X_C}{(X_L - X_C)\, X_L X_C}$$

where the symbols are defined in "Per cent ripple, single-section filter" above.



Power supply
Filter design

Figure 6-4 is an alignment chart for determining the constants of a single section constant-K low-pass filter in terms of the cutoff frequency and the load resistance. The cutoff frequency should be set at about two-thirds the value of the fundamental ripple frequency (120 cps for full-wave rectification, 60 cps for half-wave, in 60-cps circuits).

Resistance-capacitance filter

Figure 6-5 shows the reduction in ripple percentage (input ripple volts per output ripple volt) for R-C single-section filters.

Electronic Relay Circuits

Electronic relay

See Fig. 6-6

Actuating grid voltage

$$E_c = \frac{I_L(R_L + r_p)}{\mu} \text{ volts}$$

where E_c is the increment in grid voltage in volts, (in addition to the fixed grid bias) required to actuate the relay, I_L is the corresponding increment in plate current (in addition to the d-c plate current allowed to flow by the fixed grid-bias voltage) which will cause the actuation of the relay, R_L is the resistance of the relay coil, r_p and μ are the dynamic internal resistance in ohms and amplification factor of the amplifier tube.

Time-delay relay

Typical time delay relay circuits are shown in Fig. 6-7.

Time delay (condenser charging). Fig. 6-6A.

$$t = 2.3\, RC \log_{10} \frac{E}{E - E_c} \text{ seconds}$$

where t is the time between the closing of the switch and the actuation of the relay, R is the delay circuit resistance in ohms, C the delay circuit capacitance in farads, E the value of the voltage supply connected to the RC circuit by the switch, and E_c the value of grid voltage at which the relay is actuated (see "Electronic relay," above), both in volts.

Time delay (condenser discharging). Fig. 6-6B.

$$t = 2.3\, RC \log_{10} E/E_c \text{ seconds}$$

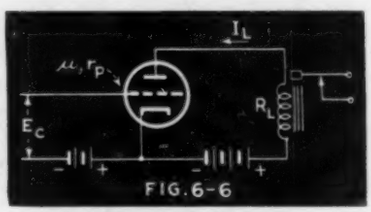
where t is the time between removing the voltage supply from the RC circuit and the actuation of the relay, E is the voltage to which the capacitor is initially charged, E_c is the increment of grid voltage at which the relay is actuated (see "Electronic relay," above), R is the delay circuit resistance in ohms, and C is delay circuit capacitance in farads.

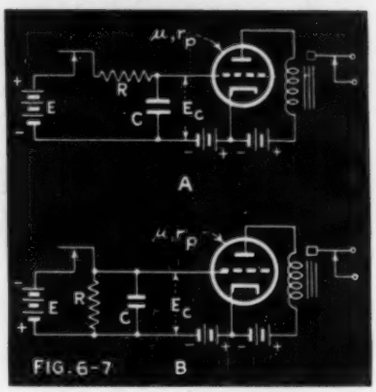
Phototube relay

Actuating light flux. See Fig. 6-8.

$$L = \frac{E_c}{SR_c} \text{ lumens}$$

where L is the increment in light flux falling on the phototube cathode required to actuate the relay, S the luminous sensitivity of the cathode in microamperes per lumen, R_c the coupling resistance in megohms, and





E_c is the increment in grid volts required to actuate the relay (see "Electronic Relay" above).
The plate current increases with increasing light when the phototube cathode is connected to the relay amplifier grid. The plate current decreases with increasing light when the phototube anode is connected to the relay amplifier grid.

Gas-Tube Photo-relay

Figure 6-9 shows a simple phototube relay employing a gas-filled relay tube, designed for operation on a 115-volt a-c power line.

Capacity operated relay

A sensitive capacity-operated relay designed for an 115-volt a-c power line is shown in Fig. 6-10.

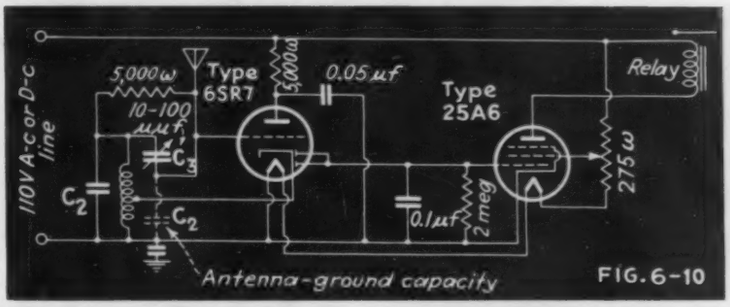


FIG. 6-10

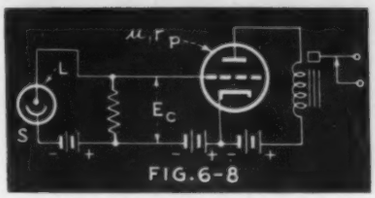


FIG. 6-8

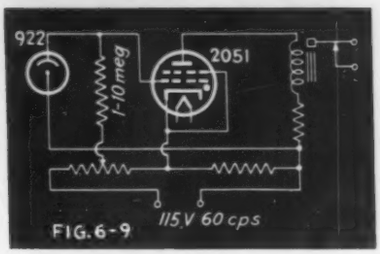


FIG. 6-9

References:

1. Radio Engineering Handbook, 3rd Edition, McGraw-Hill, 1941.
2. Electrical Engineer's Handbook, Vol. 5, Wiley, 1936.
3. RCA Tube Handbook, HB-3.
4. Fink, "Engineering Electronics," McGraw-Hill, 1938.
5. George, Relays in Tube Output Circuits, ELECTRONICS, August, 1937.
6. Noble, Industrial High Frequency Power, ELECTRONICS, October, 1935.

SECTION 7: MEASUREMENTS

Current and Voltage

Design of ammeter shunts

Resistance of shunt

$$R_s = \frac{R_m I_m}{I - I_m} \text{ ohms}$$

where R_s is the resistance placed in shunt with an ammeter to extend its range, R_m is the internal resistance in ohms of the meter, I_m is the full scale current of the meter without the shunt, in amperes, and I is the full scale current of the meter with the shunt, in amperes.

Multiplying factor, ammeter shunt

$$K = \frac{R_s + R_m}{R_s} \text{ times}$$

where K is the ratio of the full scale current with the shunt to the full scale current without the shunt, both in amperes, R_s is the shunt resistance in ohms, and R_m is the meter resistance in ohms.

Design of voltmeter multipliers

$$R = R_m\left[\frac{E}{E_m} - 1\right] \text{ ohms}$$

where R is the multiplier resistance in series with the voltmeter, R_m is the internal resistance of the meter in ohms, E_m the full scale voltage of the meter without the multiplier, and E the full scale voltage of the meter with the multiplier.
When a milliammeter movement is used, E_m is ordinarily small, compared with E. The above expression then reduces to

$$R = E\,(R_m/E_m) \text{ ohms}$$

where the factor R_m/E_m is a constant of the meter, in ohms per volt, R_m/E_m is the reciprocal of the full scale current of the meter. Typical values are 1000 ohms per volt (1 ma full scale current), and 20,000 ohms per volt (50 μa full scale). Typical value of R_m for a 1-ma meter is 27 ohms.

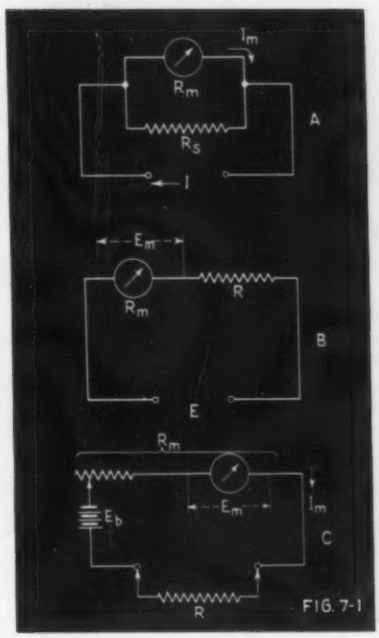


FIG. 7-1

Shunt-multiplier table

Table I gives typical shunt and multiplier resistance, for a 27-ohm, 1-ma basic meter.

TABLE I — SHUNTS AND MULTIPLIERS

(For use with 0–1 ma milliammeter, meter resistance 27 ohms)

Scale*	Shunt (Ohms)	Multiplier (Ohms)
0–10	3.0000	10,000
0–50	0.5510	50,000
0–100	0.2727	100,000
0–500	0.5410	500,000
0–1000	0.0271	1,000,000

*** Scale in ma when used with shunt, in volts when used with multiplier.**

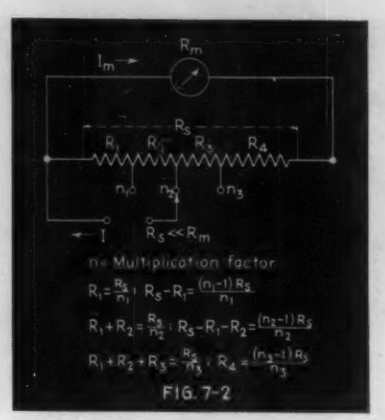


FIG. 7-2

Ohmmeter Calibration (See Fig. 7-1)

$$R = R_m\left(\frac{E_b}{E_m} - 1\right) \text{ ohms}$$

where R is the value of resistance measured, E_b the battery voltage in volts in the ohmmeter circuit, R_m the resistance of the meter and zero-adjusting rheostat, and E_m the voltage read on the scale of the meter (equal to product of current read on meter times meter resistance).

The resistance R_m is adjusted, with the terminals of the ohmmeter short-circuited, until full scale current is reached. The major portion of R_m is the resistance of the rheostat employed for this purpose.

Usually the battery voltage is large compared with the voltage across the meter. Then

$$R = E_b/I_m \text{ ohms}$$

where E_b is the battery voltage in volts and I_m is the current (E_m/R_m) in amperes flowing through the meter.

Universal shunt

Figure 7-2 gives the circuit and design relationships of a three-tap universal shunt.

Errors in voltage measurement

If a voltmeter draws appreciable current from the source being measured, the indicated voltage will be lower than the true value (with the voltmeter disconnected) by the following amount:

$$E_{error} = I_m R_s \text{ volts}$$

where I_m is the current drawn by the voltmeter and R_s is the effective internal series resistance in ohms of the source being measured.

The internal resistance R_s of the source may be determined by connecting a known resistance in series with the voltmeter and the source, and noting the voltage reading with the extra resistance. The internal resistance is then given by—See Fig. 7-3

$$R_s = \frac{V_1 - V_2 - I_2R_2}{(I_2 - I_1)} \text{ ohms}$$

where V_1 is the voltage in volts measured before inserting the external resistance V_2 the voltage in volts after inserting the external resistance, I_1 and I_2 are the corresponding meter currents in amperes and R_2 is the value of the external resistance in ohms.

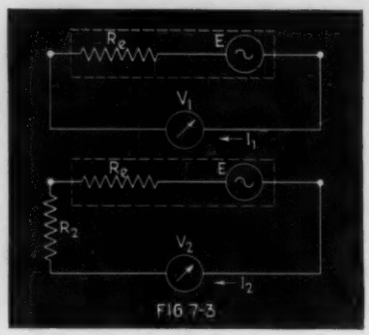


FIG 7-3

Bridge measurements[4]

See Fig. 7-4

Resistance measurement (Wheatstone Bridge)

See Fig. 7-4A. At balance, when the potential between points A and B is zero, the unknown resistance is

$$R_x = \frac{R_1R_2}{R_3} \text{ ohms}$$

Capacitance measurement (Series Resistance Bridge)

See Fig. 7-4B. At balance, when the potential between points A and B is zero, the unknown capacitance is given by

$$C_x = C_1(R_2/R_1) \text{ farads}$$

The following condition also must be fulfilled

$$R_3/R_4 = C_x/C_1$$

Inductance measurement (Anderson Bridge)

See Fig. 7-4C. At balance, when the potential between points A and B is zero, the unknown inductance is given by

$$L_x = C[R_5(R_1+R_2) + R_2R_3] \text{ henries}$$

The two conditions of balance are

$$R_1 = \frac{R_2R_3}{R_4}$$

and

$$L_x = CR_2\left[R_5\left(1 + \frac{R_3}{R_4}\right) + R_3\right]$$

Frequency measurement (Wien Bridge)

See Fig. 7-4D. At balance, when the potential between points A and B is zero,

$$f = \frac{1}{2\pi C_1R_1}$$

The following conditions must also be fulfilled:

$$C_1 = C_2 \text{ farads}$$

$$R_1 = R_2 \text{ ohms}$$

$$R_4 = 2R_3 \text{ ohms}$$

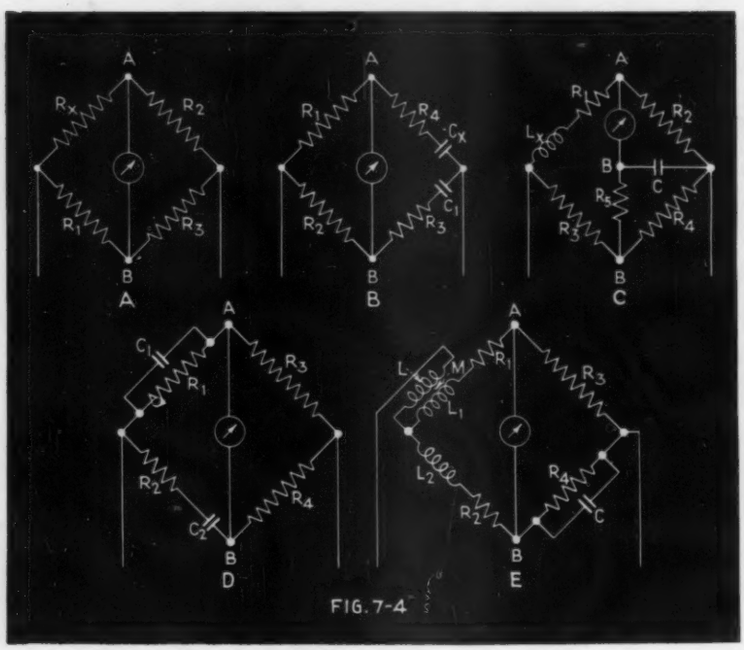


FIG. 7-4

Mutual Inductance

See Fig. 7-4E. At balance, when the potential between points A and B is zero,

$$M = \frac{R_3 R_2 C}{2} \text{ henries}$$

and

$$M_1 - L_1 = \frac{R_1 - R_2}{(2\pi f)^2 R_3 C}$$

where f is the frequency of operation in cps.

The bridge is constructed with $R_3 = R_4$, and $L_1 = L_2$.

R-f Power Measurement[5]

Lamp and Photometer Method

Figure 7-5 shows a method of measuring r-f power sources up to approximately 500 watts, at frequencies up to about 20 Mc. The incandescent lamp is placed in an integrating sphere, where it is viewed by a photometer or photoelectric light meter. The readings of the photometer or light meter are calibrated at 60 cps against power input to the lamp using a voltmeter and ammeter, or wattmeter. This calibration holds for r-f power so long as skin effect is not too prominent in the filament. Note that the inductance of the coiled filament used in modern lamps unless resonated with series or shunt capacitance may introduce improper termination of the r-f transmission line, resulting in less than maximum power transfer to the lamp.

Rectifier method[5]

Fig. 7-6 shows a rectifier circuit for measuring r-f power. The r-f power is given by

$$P_{rf} = nP_{dc} \text{ watts}$$

where P_{dc} is the power indicated by the wattmeter in the diode circuit, and n, the power rectification efficiency of the diode is given by

$$n = \frac{2\sin\pi\beta - 2\pi\beta\cos 2\pi\beta - 2\pi\beta}{2\pi\beta - \sin 2\pi\beta}$$

where β is the total angle in electrical radians during which anode current flows in the rectifier.

The power may also be measured in terms of vacuum-tube voltmeter readings, as

$$P_{rf} = \frac{E_{ac}^2}{2\pi R_p}(\pi\beta - \sin\pi\beta\cos\pi\beta)$$

where E_{ac} the peak a-c voltage across the rectifier, R_p is the internal resistance of the diode while conducting and β is the conduction angle defined immediately above.

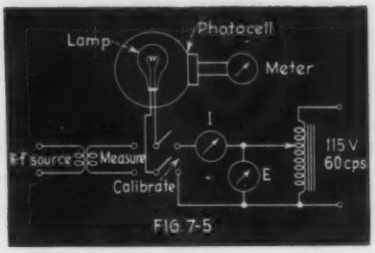
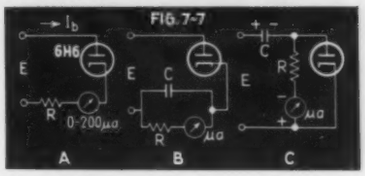


FIG. 7-5



Vacuum-Tube Voltmeters

Diode linear voltmeter[2, 3]

See Fig. 7-7A. When the resistance R is high (100,000 ohms or more), the calibration for direct voltage is

$$I_b = E/R \ \mu a$$

where E is the applied direct voltage in volts and R is the load resistance in megohms.

Calibration

The calibration on alternating voltage is

$$I_b = \frac{E_{rms}}{2.22R} \ \mu a$$

where I_b is the average d-c current through the diode, E_{rms} is the r-m-s alternating voltage applied, and R is the load resistance in megohms. The a-c calibration applies to all frequencies up to that at which the diode capacitive reactance becomes smaller than ten times the load resistance (above 20 Mc).

Diode Peak Voltmeter[2, 3]

Figure 7-7B shows a peak diode voltmeter. The RC product is not less than

$$RC = 100/f \text{ ohm-farads}$$

where R is the resistance in ohms of the diode load, C the capacitance in farads, and f the frequency of operation in cps. The value of R should be about 100,000 ohms at high frequencies, 1.0 megohm at low frequencies.

Input Resistance

The input resistance of the series diode peak voltmeter is approximately

$$R_{in} = R/2 \text{ ohms}$$

where R is the load resistance in ohms.

Calibration

The calibration of the peak voltmeter is linear for voltage inputs greater than several volts. The calibration is equal to

$$I_b = \frac{E_{peak}}{R} \ \mu a$$

where I_b is the average direct current flowing through the load resistance, E_{peak} is the peak value of the positive anode half cycle of the applied a-c volts, and R is the load resistance in megohms.

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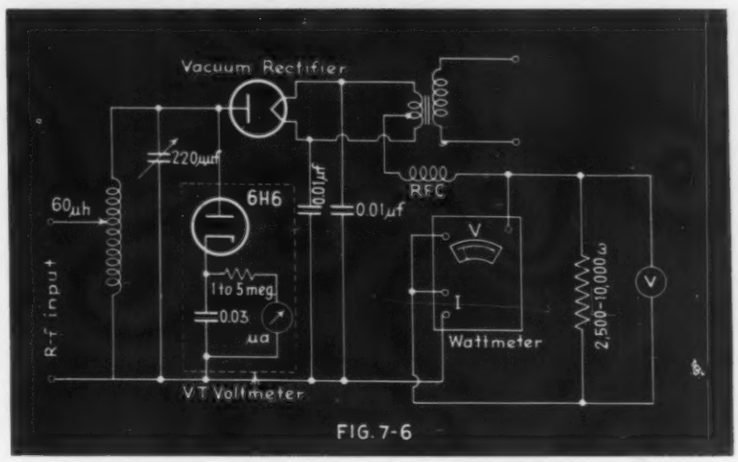

FIG. 7-6

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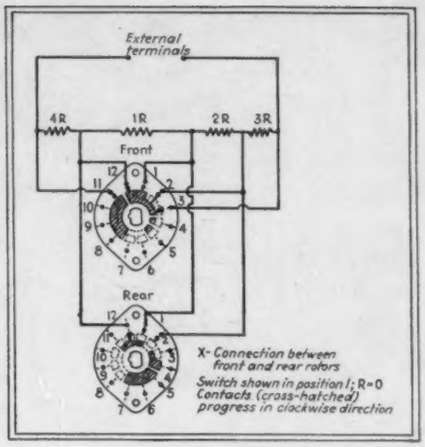
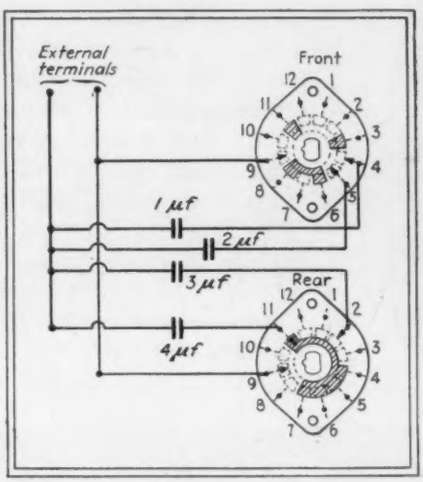
TUBES AT WORK

Discussed in this issue are the following topics: decade resistance and condenser switching, measurement of iron core inductances, diesel-electric power for broadcast stations, a humidity meter, and pulsation welding of metal



Wiring diagram for decade resistance unit. Resistances of *R*, *2R*, *3R*, and *4R* are wired to produce unit steps up to *10R* inclusive



Wiring diagram of switching arrangement for decade condenser. Four condensers are required. The diagram shows condensers for 10 μf maximum range

Decade Resistance and Condenser Switches

By T. G. ANDERSON
Owensboro, Ky.

A COMPARATIVELY SIMPLE and highly effective method of producing a decade switching arrangement for resistance or capacitance with a minimum number of parts, all of which are readily available, may be seen from the accompanying tables and description. In the simplified rotary switching system for decade resistor units, only four resistors are used in various combinations to provide resistance changes in ten equal steps. The only units required are four resistors having the appropriate resistance values, which will be designated respectively as *R*, *2R*, *3R* and *4R*, respectively, and a small wafer type-switch having eleven steps as used by radio manufacturers. The values of the resistance, *R*, may have any value, although it is most convenient if these are in decimal multiples such as 1, 10, 100, 1000 ohms, or the like.

The wafer type of switch illustrated in the diagram is manufactured by several radio assembly firms, although the switch made by the Oak Mfg. Co., of Chicago is used for purposes of illustration. The switch used here for both the resistance and capacitance decades is the type H. In looking at an assembled switch from the shaft end with rotor in counter-clockwise position, the rotors and clips on front of the wafer would be recognized from the switch drawing. In looking at the rotors and clips from the rear of the wafer, this is not true unless we imaginarily look through from the front to observe the working part on the rear. Therefore, in analyzing the functional drawing, remember that the rotational changes on front and back of rotor are viewed from the front, as this method maintains proper angular relationship between the two sides as the rotor returns. Reference to the schematic diagram will make it possible to determine the resistance across external terminals for each of the 11 switch positions.

The accompanying schematic diagram indicates the connections which are to be made to connect the four resistances in a suitable decade box. Additional data which may be of use in assembling the switch is given in Table I. In this table the letters *FC* refer to the front set of contacts and the numbers correspond with those on the schematic diagram. Likewise, the letters *RC* refer to the numbered contacts on the rear section of the switch.

It may require a little study to determine the proper method of wiring up the switch and the four resistors, but once this unit is correctly wired and tested, a very convenient decade resistance is available from which resistance values between the external terminals may be determined by a calibration on the panel and without reference to any further tables, charts or diagrams. The further advantage of the unit of this construction is the low cost and small size with which the unit may be built.

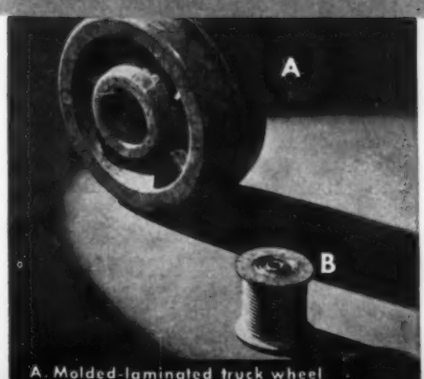
A simple and convenient switching arrangement of a decade capacitance using four condensers and a single sec-

Table I.—TABLE OF CONNECTIONS FOR DECADE RESISTANCE BOX

Position	Total Resistance	CONNECTIONS FOR RESISTOR							
		1R		2R		3R		4R	
		FC	RC	FC	RC	FC	RC	FC	RC
1	0	1, 2, 3, 12	NC	1, 2, 3, 12	NC	1, 2, 3, 12	NC	11	12
2	1R	.....	NC	1, 2, 3	NC	1, 2, 3	NC	11, 12	NC
3	2R	1, 11, 12	NC	.....	NC	2, 3	NC	1, 11, 12	NC
4	3R	1, 2, 11, 12	NC	1, 2, 11, 12	NC	.....	NC	1, 2, 11, 12	NC
5	4R	1, 2, 3, 12	NC	1, 2, 3, 12	NC	1, 2, 3, 12	NC	.....	NC
6	5R	.....	NC	1, 2, 3	NC	1, 2, 3	NC	.....	NC
7	6R	NC	1, 12	.....	NC	2, 3	NC	.....	NC
8	7R	NC	1, 2, 12	NC	1, 2, 12	.....	NC	.....	NC
9	8R	.....	NC	.....	1, 2	.....	NC	NC	NC
10	9R	NC	1, 12	.....	NC	.....	NC	.....	NC
11	10R	.....	NC	.....	NC	.....	NC	.....	NC

FC — Front Contact
RC — Rear Contact
NC — No Connection
... Open Circuit
Clips Nos. 1, 2, and 12 are electrically connected, front and rear. Front rotor section connecting clips 12 to 3, inclusive, is non-shorting type.

MID WATCH



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tion wafer type of switch of suitable design can be made in a similar manner. It is suitable where the capacitance of each step is 1000 $\mu\mu$f or more, provided the precision of the individual unit is sufficiently accurate. For a range of less than 1000 $\mu\mu$f per step, the wiring capacitance may introduce an error which may be appreciable. It is likely that steps of 100 $\mu\mu$f will be practical if account is taken of the residual capacitance, but it is not recommended that the condensers be used for capacitances of less than this per step.

Decade resistance switch (left) and decade condenser switch (right) made from standard radio components

The table and schematic wiring diagrams indicate the essential connections using four condensers whose capacitances are respectively C, $2C$, $3C$, and $4C$. In the schematic wiring diagram, the switch connections, shown cross-hatched, are shown in the initial or zero capacitance condition, and the only capacitance in the circuit is that of the wiring. As the switch is rotated in a clockwise direction, as we view the switch diagram, the connections indicated in Table II will come into play, adding the appropriate capacitance unit in parallel. In tracing through these connections, it should be pointed out that all of the contacts (4, 5 and 9 of the front set, and 2, 9 and 11 of the rear set) are not all of the same length. Contact 4 of the front and 2 of the rear elements are short terminals and make contact with the cross-hatched arm of the switch when the switch segment projects to the edge of the dotted circle. The remaining contacts are longer and make contact with the inner rotating circular segment.

Table II.—Connections for Decade Condenser Box

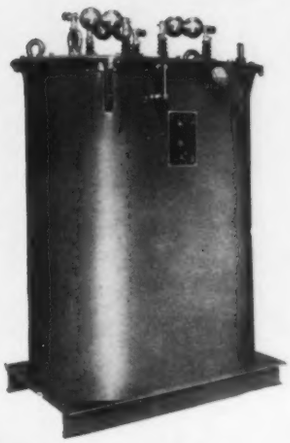
Position	Total Capacitance	Front Rotor	Rear Rotor
1	0		
2	1C	4, 9	NC
3	2C	5, 9	9
4	3C	9	2, 9
5	4C	NC	9, 11
6	5C	4	9, 11
7	6C	9, 5	9, 11
8	7C	NC	2, 9, 11
9	8C	4	2, 9, 11
10	9C	5	2, 9, 11
11	10C	4, 5, 9	2, 9, 11

NC — No Connection

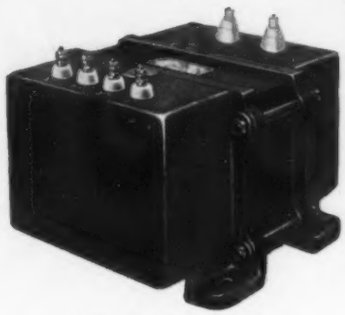
. . . IN ALL RATINGS; FOR ALL REQUIREMENTS

Transformers for Electronic Circuits

Type RS plate transformers and reactors, oil-immersed type, for large rectifiers.



AmerTran modulation transformer, oil-immersed type, for large broadcast transmitters.



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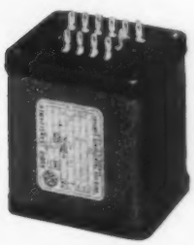

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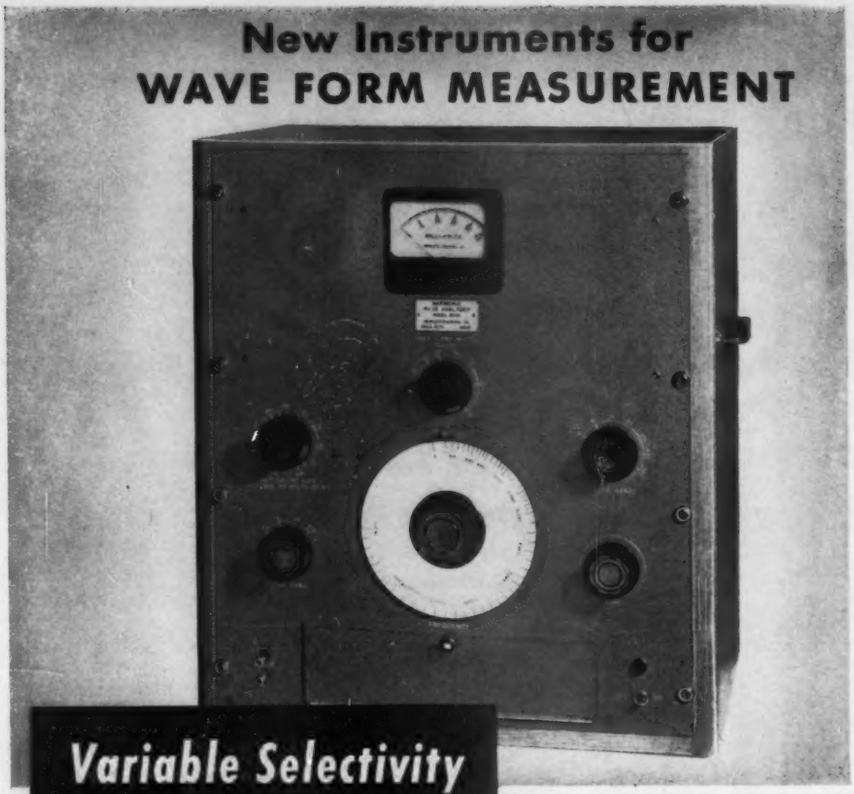

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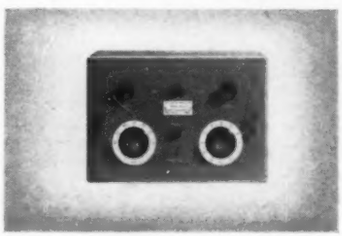

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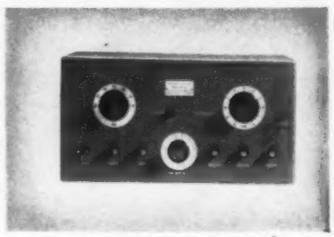
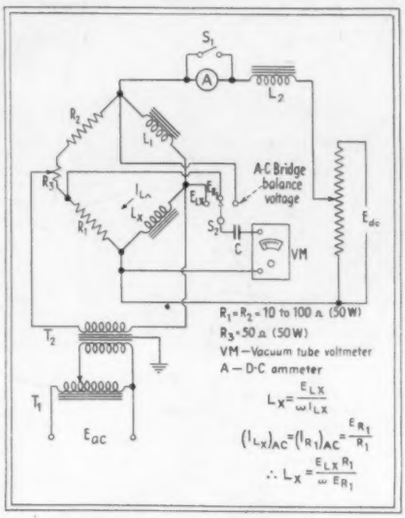


Measurement of Low Range Iron Core Choke Coils

By S. Uchida and M. Yamamoto

The equipment described here has been used to measure incremental inductances of choke coils having values of inductance less than about 0.5 henry. It is a combination of voltmeter-ammeter and bridge methods. As shown in the wiring diagram, two similar chokes, L_1 and L_2, are connected in series with the d-c source. Two fixed resistors, R_1 and R_2, and a potentiometer, R_3, are connected in series and shunted across the chokes. The resistance of these resistors is made considerably higher than the d-c resistance of the chokes to prevent excessive d-c power loss in the circuit.

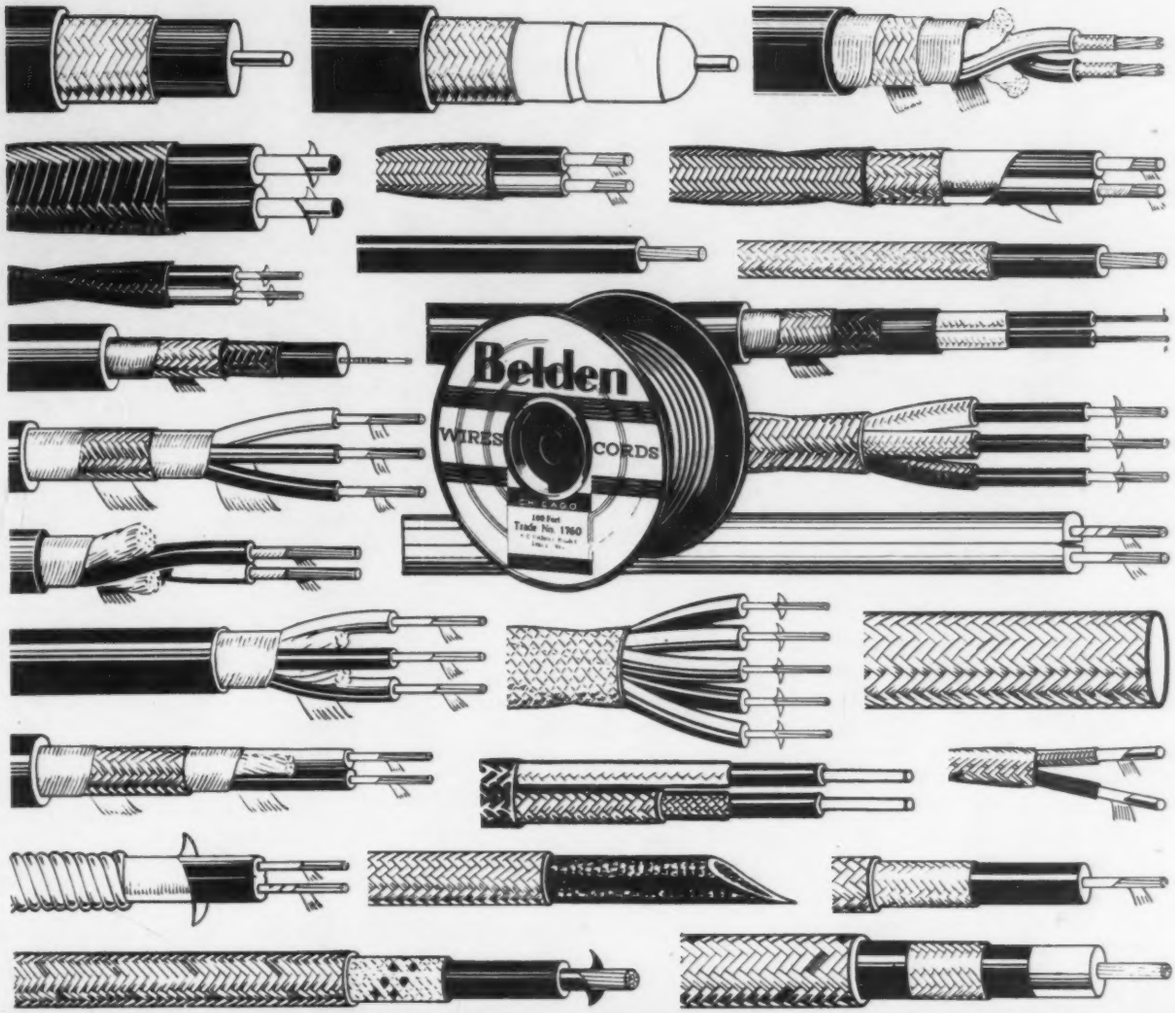
In operation, the bridge is balanced by applying an a-c voltage from a continuously variable autotransformer T_1 and a shielded transformer T_2 of suitable voltage output. The null balance is obtained by adjustment of R_1 and indicated by the vacuum tube voltmeter, VM. If L_1 and L_2 are of the same characteristics, this point should not be difficult to determine. Theoretically, at balance, no direct current will flow in the secondary winding of the transformer, and no alternating current will flow in the d-c circuit. This condition is difficult to obtain actually but the leakages caused are negligible. The use of


A-C Bridge balance voltage
VM
$R_1 = R_2$ = 10 to 100 Ω (50 W)
R_3 = 50 Ω (50 W)
VM — Vacuum tube voltmeter
A — D-C ammeter
$L_x = \frac{E_{LX}}{\omega I_{LX}}$
$(I_{LX})_{AC} = (I_{R_1})_{AC} = \frac{E_{R_1}}{R_1}$
$\therefore L_x = \frac{E_{LX} R_1}{\omega E_{R_1}}$

Bridge circuit arrangement for the measurement of incremental inductance of iron core coils

an auxiliary choke L_2, if available, in the d-c circuit is recommended.

The current in L_x is determined from the voltage drop in R_1, and the a-c voltage across L_x by means of a vacuum tube voltmeter. The determination of the null point, and measurement of the a-c components in L_x may be made by means of a multi-range vacuum tube voltmeter. A three-point switch S_2, is required for this function. It is essential that a blocking condenser C of good insulation be used in the vacuum



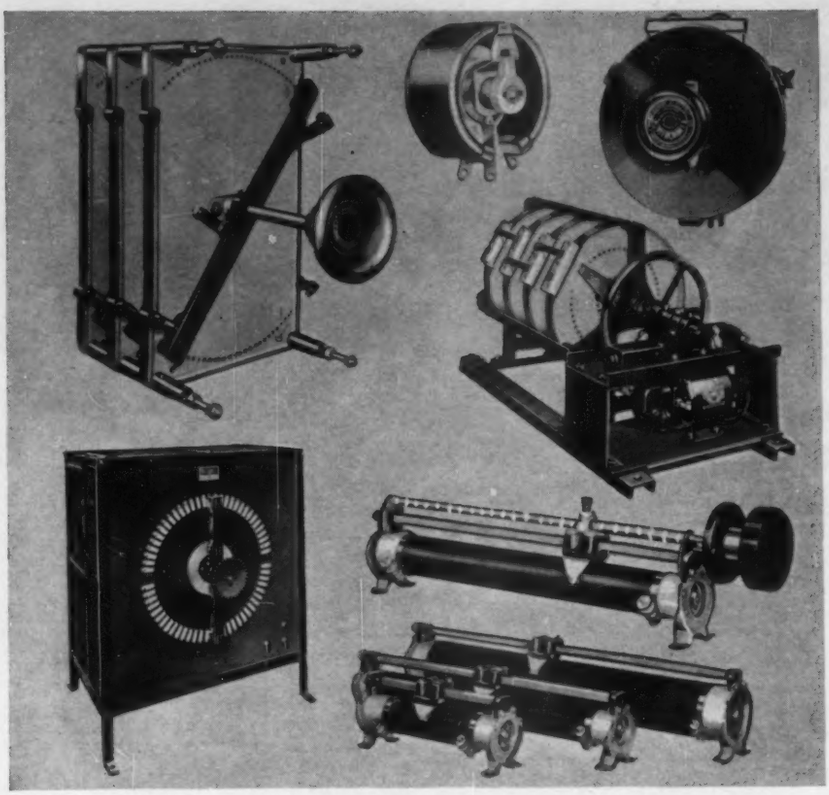
TODAY, WE DON'T SAY "WIRELESS"

From the start, the most important factor in "WIRELESS" was WIRE. Perhaps that is why its name was changed.

From the start, however, the name of the most important factor in good radio wire has not changed. It has always been—and still is

Belden

—the Wire FOR GOOD CONNECTIONS



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tube voltmeter because of the presence of the d-c component in the bridge network.

The d-c ammeter A may be placed in the d-c circuit when the total resistance of R_1, R_2, and R_3 in series is greater than about 25 times that of the d-c resistance of L_1 and L_2. This is the usual case for low range choke coils, and the error in the reading is low. A correction may be applied in case a considerable portion of the d-c component flows in the resistance branch. Otherwise, the ammeter should be placed in series with L_1. The former arrangement is preferred because the a-c component will not then flow in the ammeter coil at balance. A shorting switch, S_1, across the ammeter is necessary since surges are produced when the d-c source is opened.

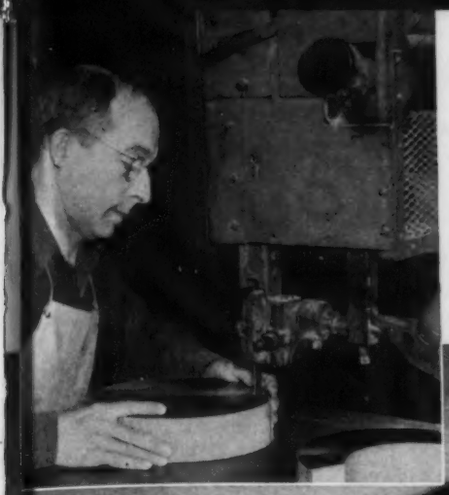
The resistances of R_1 and R_2 can be varied suitably to fit conditions, providing that they can dissipate the heat caused by the effective current (mostly alternating) in the circuit. Most of the equipment is available in laboratories and so the set-up can be made quickly. The method has been found very satisfactory and convenient for the rapid measurements of choke coils for filament circuits, and similar uses. In place of the easily burnt-out thermocouples, the versatile vacuum tube voltmeter is used for current indication. In addition, large capacitances required in certain other methods are not needed. Originally, this circuit was developed to obviate the need of these condensers.

• • •

Development in Facsimile

WORKING FOR YEARS to develop the automatic telegraph, by means of which telegrams are received as a facsimile of what is sent, Western Union engineers had no idea that an off-shoot of their facsimile apparatus would be the Multifax, an important new business machine which automatically prepares metal master plates, paper stencils,

Multifax unit of Western Union, with which stencils, master plates and tracings are prepared from original copy



DEFENSE USES LAMICOID

. . . for the Same Reasons it is used for so many "non-defense" applications

Whether you have a defense contract or not—these are times of rapid expansions, rush schedules and sudden changes. No one can afford to wait—and laminated plastic materials must be delivered as promised and be *right* the first time!

At Mica Insulator Company we are equipped to fabricate Lamicoid for thousands of applications . . . in the aircraft, radio, electrical, transportation, chemical and many other industries. Defense uses Lamicoid for the same combination of properties that has made it especially useful for so long in "non-defense" applications. Any part which must be light in weight, structurally strong, easy to machine, resistant to corrosive action as well as an excellent electrical insulator—is a likely application for Lamicoid. It is available in sheets, rods and tubes for fabrication in your own plant—or as completely finished parts and products. In addition to our own fabricating facilities, our experienced fabricators are located in the principal industrial centers to give you prompt service and the finest precision work that modern equipment can produce.

If you will send us details of your requirements, or a blue print of the application you have in mind—we will be pleased to quote prices.

LAMICOID
REG. U. S. PAT. OFF.

Mica Insulator Company
200 Varick St., New York; 542 So. Dearborn St., Chicago; 1276 W. 3rd St., Cleveland. *Branches at* Birmingham, Boston, Cincinnati, Los Angeles, San Francisco, Seattle. *Canada:* Montreal, Toronto.

MICA INSULATOR COMPANY

RUGGED FOR THE HARD KNOCKS OF PORTABLE DUTY; PRECISION-BUILT FOR PERFECT OUTDOOR-INDOOR PERFORMANCE

There is definite ruggedness and dependability in the Fairchild portable recorder. Rigidly constructed in every respect, this equipment can "take it"—can stand up under the punishment to which it is subjected, and which is expected, naturally, when transported from one location to another in automobile or sound truck.

The entire mechanism is mounted on a heavy aluminum panel which can be set or mounted in a cabinet or control room console to become permanent studio equipment. One can appreciate the fact that quality performance under the stress and strain of portable and on-location duty, is further enhanced by proper installation in a secure cabinet where it has stability and other operating advantages and where it can be given reasonable service attention.

Fairchild is the ideal performer under any and all conditions. Write for free illustrated literature.

Illustrated above is Fairchild Unit 199-3 Recording Mechanism. For recording and playback, the unit is provided with cables and plugs for instantaneous hookup to the Fairchild Unit 219-2 Amplifier or the Fairchild Unit 295 Amplifier. These combinations provide a complete, self-contained, portable outfit for the direct recording of voice, music and sound, and for the direct playback of this recording.

"...it had to satisfy Fairchild first"

FAIRCHILD
Sound Equipment Division
AVIATION CORPORATION
88-06 Van Wyck Boulevard, Jamaica, L. I., N. Y.

hectograph master copies and tracings from written matter, blueprints or drawings.

Automatic reproduction of master copies by Multifax is accurate because the copies are exact facsimiles and need not be compared with originals. The time consumed in producing master copies is reduced by almost 50 per cent. Even greater savings are possible if the text is complex, containing tabulations, forms, drawing, sketches, maps, etc. Master copies 8½ x 11 inches are made in 12 minutes, and those 11 x 17 inches in 24 minutes. The Multifax may be briefly described as a metal cylinder, or drum, upon one end of which the original matter is placed, and upon the other end the metal plate, wax stencil or other material upon which the master copy is to be produced. The original is scanned by a beam of light which moves laterally along the revolving cylinder. The beam is reflected to a phototube and the minute electrical currents there generated are amplified to energize an electromagnet which operates a stylus impinging upon the material upon which the master copy is to be prepared. As dark areas are scanned the stylus is brought into contact with the surface; as light areas are scanned the stylus is retracted. The operation of the machine is so simple that any one can use it after a short period of instruction.

• • •

SENATOR SHEPPARD VIEWS "BLACKOUT MACHINE"

Senator Morris Sheppard of Texas, Chairman of the Military Affairs Committee, and Col. David A. Watts recently attended a demonstration of a "blackout machine" invented by Eugene C. Pomeroy and Robert M. Franklin. The inventors claim the device could be used to shut off power facilities in every city in the United States in the event this should become necessary as a national defense and safety measure

- **Centralab Volume Controls**
- **Centralab Fixed Resistors**
- **Centralab Ceramic Capacitors**
- **Centralab Ceramic Trimmer Condensers**

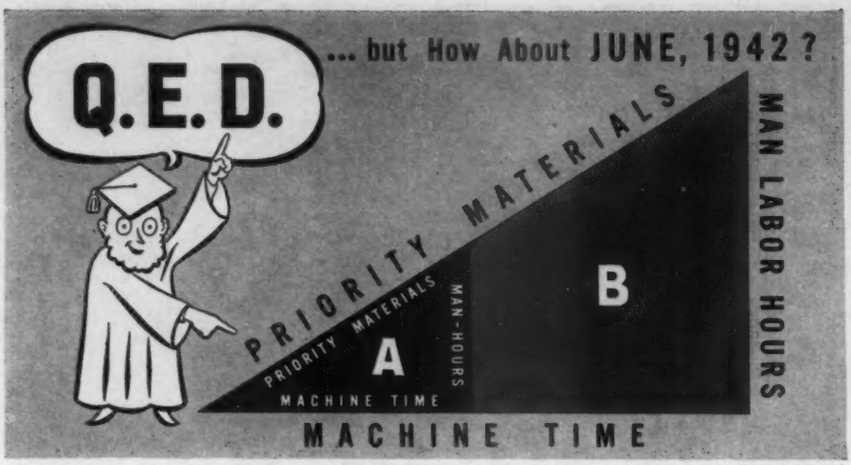
● To the AMERICAN AIRLINES, Inc. for becoming the first air transport company in the world to operate one billion passenger miles with safety . . . without fatality . . . this Special Award.

Centralab feels the glow of pardonable pride . . . for both in the air and on the ground Centralab products help to maintain the radio lines of communication so important in the proper maintenance of safe aerial traffic.

For Centralab is precision built for every radio use.

CENTRALAB: Div. Globe-Union Inc.
Milwaukee Wisconsin

Centralab



★ **Sure—your purchasing department has you covered for a year or so . . . but the demand for greater output surges UP and the need for materials, men and machines can grow acute in another twelve months . . . say, June—1942.**

If your machines and products now employ mechanical controls, you're probably wasting precious material, machine time and man-hours. (Area "B" above.) But, you AVOID this costly waste when you use . . .

RELAYS . . . *by* GUARDIAN

- INTERLOCKING CONTROLS
- RADIO CONTROLS
- LIQUID LEVEL
- AIRPLANE CONTROLS
- COMMUNICATIONS
- TIMING CONTROLS
- STEPPING RELAYS
- U. S. GOVERNMENT SPECIFIED CONTROLS
- CONTACT SWITCHES
- COUNTING UNITS
- REMOTE CONTROLS
- SOLENOIDS
- DELAYED ACTION

Yes, it's true! A small, single unit or complete control assembly can *shrink* (Area "A" above) your material, machine and labor requirements *overnight!*

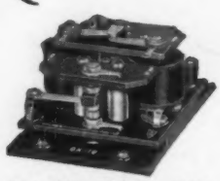
Look ahead . . . think what these savings can mean now and in the future, with Relays by Guardian doing a triple-thrifty job every day, week and month . . . besides, you replace the friction, wear and dissipated action of mechanical contrivances with smooth, dependable performance. Moreover . . .

YOU CAN SWITCH to Guardian Electric Controls quickly . . . easily . . . without re-planning your product in more than a few details. For Guardian has already spent thousands of hours developing *7,146 different *standardized* control parts for quick assembly into the very control you need.

**Inventory Count Jan. 1, 1941*

WRITE TO GUARDIAN concerning your control problem now. Or, simply ASK us to send our new FREE CATALOG "E".

Send Blueprint or Sketch for Specific Recommendations. Write



Series BK—16 Relay. Built to minimum tolerances and the most exacting requirements in production quantities for the U. S. Signal Corps.

Series 190 AC Relay. This relay which sells for less than $1 has operated over 85,000,000 times in an electric fence control, and still remains in excellent condition.

And These Are Not the Extremes in the Guardian Relay Line!

GUARDIAN ELECTRIC

1625 West Walnut Street — Chicago, Illinois

An Electronic Humidity Meter

By Esten Moen

The electrical resistance offered by a strip of paper containing a deliquescent salt depends upon the moisture in the surrounding air. The resistance may vary over a range of 10 to 1, usually in the range of 10 to 100 megohms. A peculiarity of the action is that the change is instantaneous for a change in the direction dry-to-wet, but displays a fifteen minute delay in the direction wet-or-dry.

A means of putting this effect to use is shown by the circuit in Fig. 1. A 6G5 tuning eye tube is used. The variable resistor R_2 is used to balance the circuit. From the grid of the 6G5 to R_4 a short one-inch lead is used, but from R_4 to the contact clamp a three-foot rubber covered wire serves to collect a stray electrostatic component from the 110-volt 60-cps power lines. When there is high resistance between the contact clamps, this stray signal will serve to close the eye of the 6G5. As the paper-element path between the contact clamps increases in conductivity, the control potentiometer R_3 can be turned to a point where the eye just opens. Calibration of the resistor dial

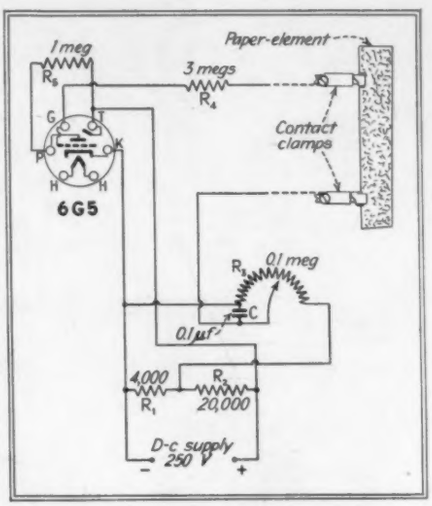


Fig. 1—Circuit diagram of electron ray tube used as an indicator of humidity

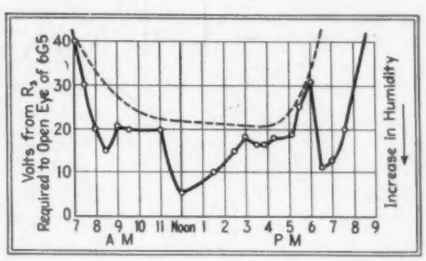
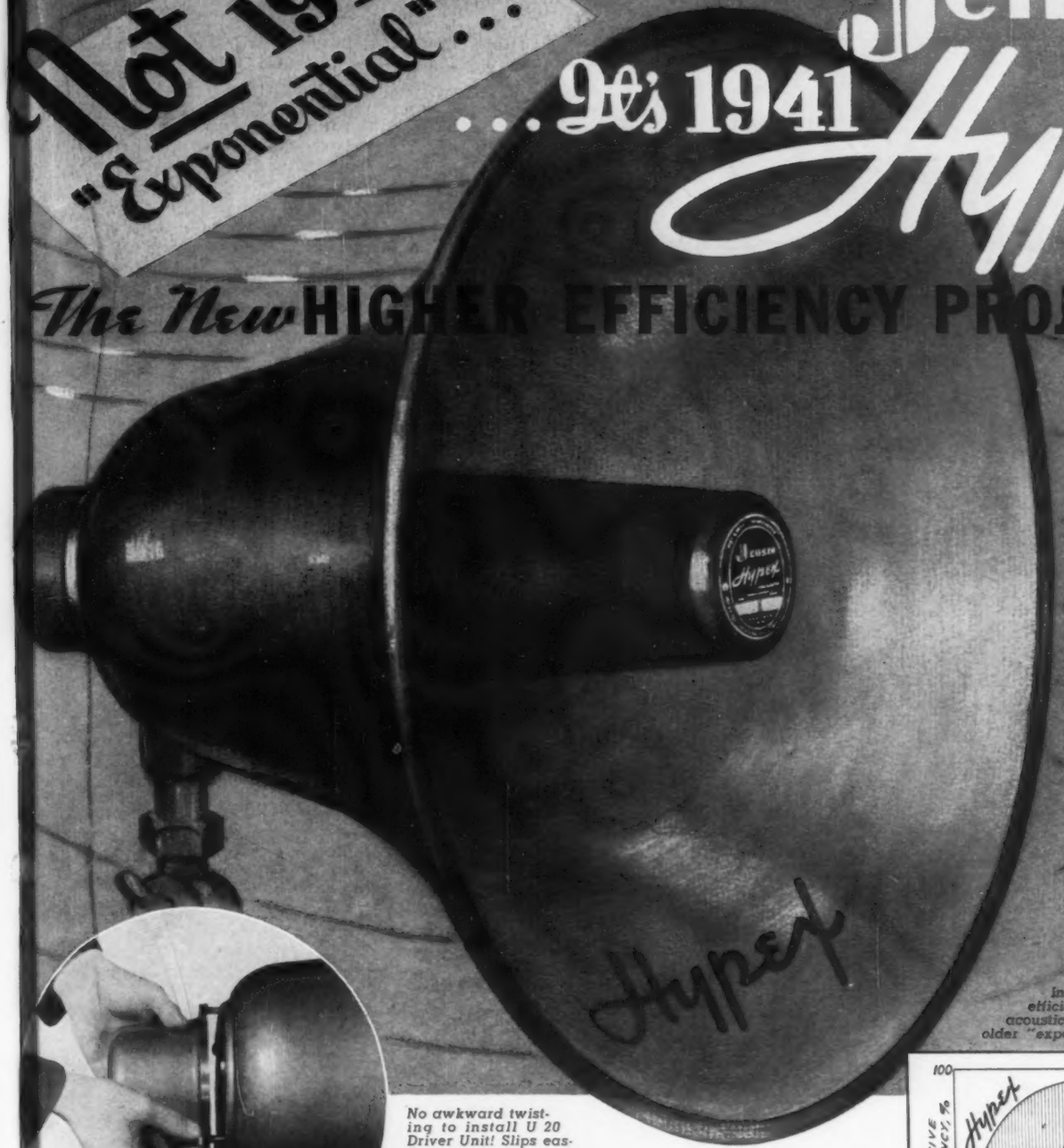


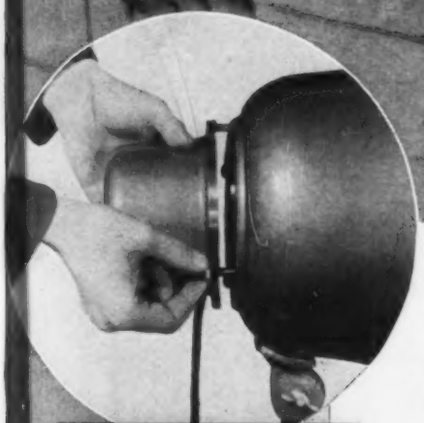
Fig. 2—Curve of humidity as recorded. Solid curve shows actual record indoors; dashed curve shows probable outdoor humidity

Not 1919 "Exponential"...

Jensen ...It's 1941 Hypex

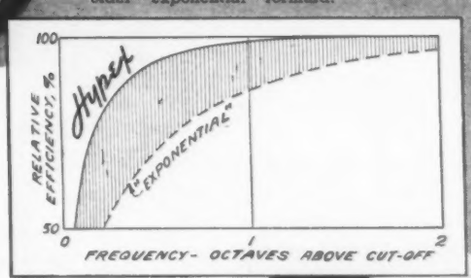
The New HIGHER EFFICIENCY PROJECTORS.



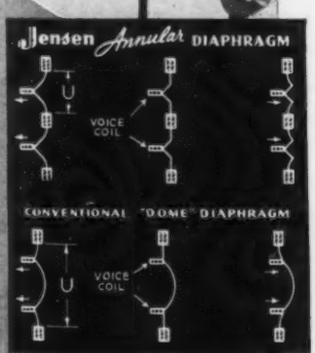


No awkward twisting to install U 20 Driver Unit! Slips easily into place . . . rigidly held to bulkhead with three nuts.

Jensen HYPEX (patents pending) brings you markedly higher efficiency because horn impedance acoustically matches driver better than older "exponential" formula.



JENSEN LEADS AGAIN WITH 2 GREAT SOUND CONTRIBUTIONS



Exclusive Jensen ANNULAR Diaphragm, supported at center as well as at periphery, is free from "breakup," smoother in response, more rugged mechanically. Note extremely short unsupported length "U" compared with conventional dome diaphragm.

Discarding 22-year-old "exponential" horn theory, Jensen Research discovered a new, better HYPEX[1] horn formula which gives improved projector performance. Then a new general-purpose ANNULAR[2] Driver Unit was designed with the exclusive annular principle long used by Jensen in the highest quality reproducing systems. Extra design features were incorporated for enhanced utility and dependability.

Either development alone would have made sound history. In combination in the new Type "UH" HYPEX Projectors, they logically become a preferred choice for high-efficiency voice and music reproduction in public-address, paging, mobile systems and all similar applications. Two Projector sizes (20" and 24" bell diameter) are now available, both Reflexed for compactness and weather exclusion, rated at 15-25 watts. List prices range from $56.50 to $64.50 in Field Coil and PM designs. (Complete Projector, less separately available adjustable stand.)

Write for Data Sheet 123—it gives complete details.

1. Patents Pending.

2. U.S. Pat. 1,845,768. Others Pend.

Weatherproof ANNULAR Driver Unit enclosed in sturdy ¼" steel case . . . husky out-of-the-weather screw terminals . . . screen-protected dustproof sound chamber . . . to mention only a few of the designed-in improvements for more dependable service.

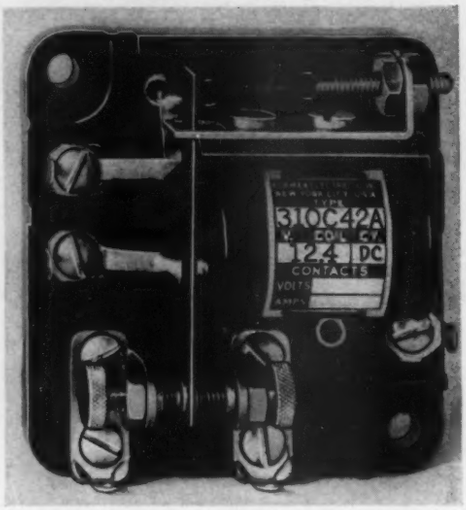
Jensen

8601 SOUTH LARAMIE AVENUE, CHICAGO

Kurman

NEWEST SENSITIVE POWER RELAY

. . . Series 300



FROM –24° TO +90° CENTIGRADE

VOLTMETER ACCURACY

of 1% pull and drop

KURMAN's newest sensitive Power Relay is the answer to insistent demand for unfaltering Relay Performance under extremes of temperature, shock, and vibration. This new series is commended to the industry as a distinct advancement.

- ***V*** **Moulded Base *(Navy approved material)***
- ***V*** **Watt Input .014**
- ***V*** **Balanced Armature**
- ***V*** **High Insulation**
- ***V*** **Output 200 to 500 Watts**
- ***V*** **Silver Contacts**

Operates on .0018 watts; operating limit of 2%, to rigid specifications of Signal Corps, Army and Navy.

Photograph Represents Model BK-25

KURMAN ELECTRIC CO.
INCORPORATED
241 Lafayette Street, New York, N. Y.

gives points of observation which can be recorded, say, at half-hour intervals during the day.

The detector element is a strip of white drawing paper, one inch wide and three inches long. Approximately three cubic millimeters of potassium acetate and 25 drops of water are mixed in a porcelain saucer and the paper is then soaked with this solution. The paper is then dried on a hot-plate.

An interesting instance of the performance of this device is shown graphically in Fig. 2. Outdoors there was considerable snow thawed in a hot sun, and although the house was closed, there was infiltration of moist air from the outdoors, and which influenced the readings. The sun rose at 5:45 A.M. but not until after 8:00 A.M. did outdoor evaporation become appreciable. Meanwhile the evaporation from water vessels on a stove caused the indoor air to become moist. The dotted line in Fig. 2 suggests the approximate outdoor humidity, free of indoor disturbances. The sun set at 6:24 P.M. but the low angle of the sun rays had prevented further evaporation an hour or more before that time.

• • •

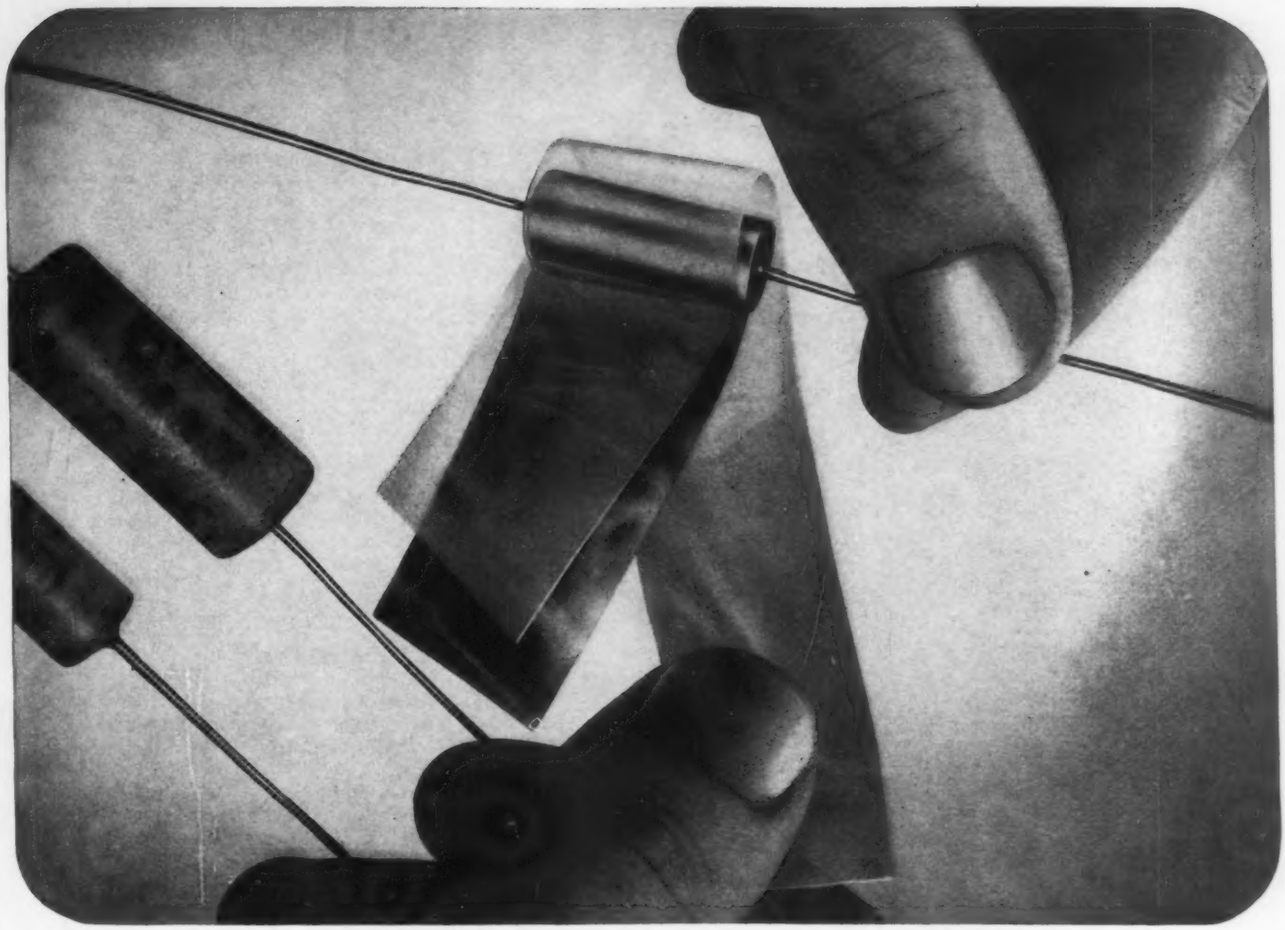
Diesel-electric Auxiliaries for BC Stations

FOR 53½ HOURS of operating time during the early part of January, station WMBD at Peoria, Ill. operated entirely from a standard 30-kw diesel-electric generator supplying electric power for all voltages required by the transmitter. The test was conducted to determine what difficulties, if any, would be experienced in powering a commercial broadcasting station by a unit com-

• • •

EYES AND EARS IN THE SKY

Modern airplanes are in constant touch with their bases through the use of radio. Here an officer of the United States Army is communicating with an observation plane during recent target practice



Now Available in Flexible, Film Form

. . . LOW-LOSS "BAKELITE" POLYSTYRENE

SUPPLEMENTING the BAKELITE Polystyrene molding materials so effectively used as low-loss insulation in high frequency apparatus, BAKELITE Corporation now offers *Polystyrene Film.*

This film is highly stable and exceptionally resistant to moisture. Its electrical properties remain constant over a wide frequency range. Because of these characteristics, BAKELITE Polystyrene Film offers many opportunities for improving the efficiency of capacitors and other parts used in electronic equipment.

BAKELITE Polystyrene Film is supplied in ¾" width and 1 mil thickness, in either water-white or purple-black tint. Other widths and thicknesses may be obtained on special order.

Enlist the services of our Engineering Advisory Staff in determining how this material may be advantageously adapted to your specific requirements.

BAKELITE CORPORATION

Unit of Union Carbide and Carbon Corporation

UCC

30 EAST 42ND STREET, NEW YORK

BAKELITE

TRADE MARKS

The word "Bakelite" and the identifying products Symbol are registered trade-marks of Bakelite Corporation

PLASTICS HEADQUARTERS

Consider these advantages of BAKELITE Polystyrene Film for high frequency equipment

POWER FACTOR
(60 to 50,000,000 cycles)
0.0002 to 0.0004

DIELECTRIC CONSTANT
(60 to 50,000,000 cycles)
2.50 to 2.60

LOSS FACTOR (60 to 50,000,000 cycles)
0.0005 to 0.0010

DIELECTRIC STRENGTH (60 cycles)
0.001" film—3500 to 4200 volt/mil"

VOLUME RESISTIVITY
Over 10^{11} megohm cms.

NORTRAN

THE DEPENDABLE

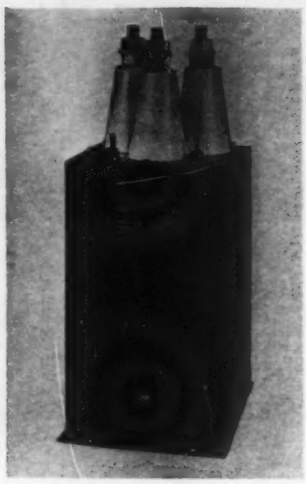
TRANSFORMER

★

Today Nortran products are specified by well known manufacturers and government agencies where exacting performance is paramount.

RECTIFIER FILAMENT TRANSFORMER

H — 12"
W — 5⅛"
D — 6"



MODEL NO. 2037

150 V. A.
20000 VOLT
H. P. TEST

•

STURDY CONSTRUCTION

This unit is playing an important role in national defense.

Nortran products are engineered to your specifications by experts.

Transformers — Reactors — Filters — Coils manufactured in our modern plant.

NORWALK TRANSFORMER CORPORATION

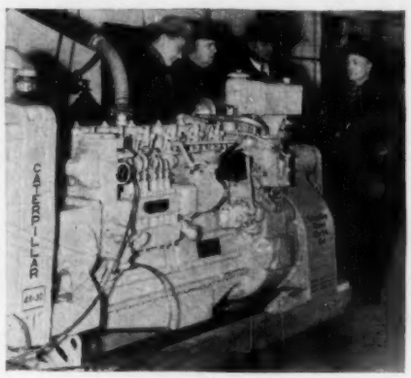
SOUTH NORWALK CONNECTICUT, U. S. A.

pletely independent of the usual power mains. The practical adaptation of a completely self-contained, oil-driven diesel-electric plant as an auxiliary has important applications in the event of local or national emergencies, and might well be investigated by stations in those areas which are likely to be visited by flood, hurricane, or severe rain or snow storms. The advantage of a completely self-contained power supply for radio stations in the event of other national emergencies also should not be overlooked.

Station WMBD is equipped with a Western Electric, low level, grid-modulated transmitter. It operates on a frequency of 1440 kilocycles, with a maximum power output of 5 kw from dawn to sunset and 1 kw during the evening and early morning hours. The transmitter draws 28 kw at 0.97 power factor, 220 volts, 3-phase, 60 cycles, when delivering 5 kw to the antenna. A five position autotransformer is an integral part of the apparatus and enables the operator to either raise or lower the incoming voltage by 10 volts.

The entire station load, including transmitter, incandescent and neon lights, is supplied by a 220-volt, 3-phase, 60-cycle circuit from three 15-kva transformers with delta-connected primaries connected to a 13,800-volt line. Standby service consists of an identical transformer arrangement, but the power is wired to it from the Powerton Station at Pekin, Illinois.

Under normal conditions, the standby service charge is consumed by the lighting load, while the local power company (Central Illinois Light & Power) serves only the transmitter.

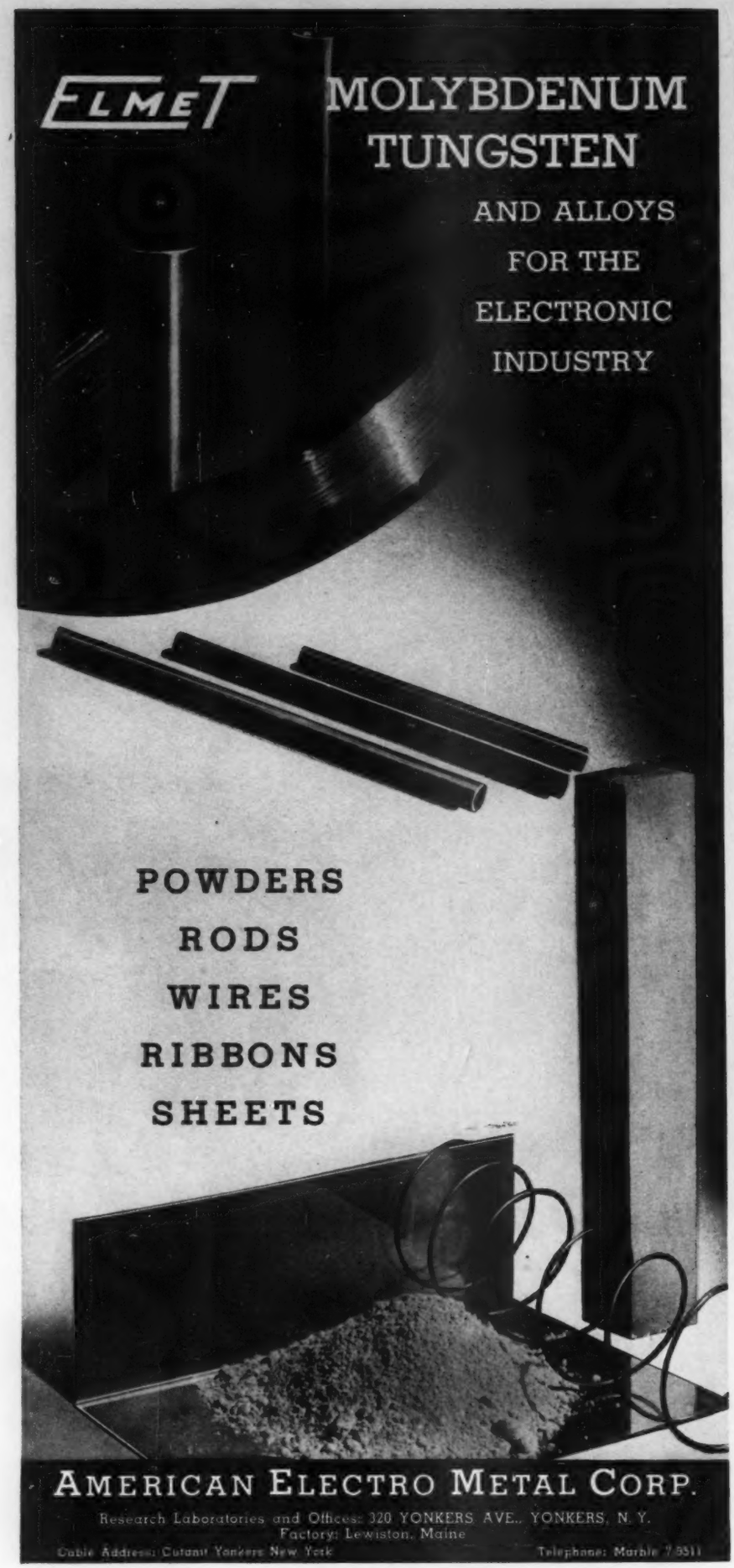


Diesel-electric, 30-kw, 220-volt generator used as auxiliary power supply at WMBD

The standard self-regulating 30-kw, 220-volt, 3-phase diesel-electric set manufactured by Caterpillar Tractor Co., was connected to the transmitter circuit. The set rested on four Firestone vibration dampers, and the exhaust was piped to a Maxim MU2-#6 muffler installed outside the building. The photograph indicates the compactness of the installation.

An initial test run was made at midnight, after the station was "off the air," and the measured distortion and

IN 1941
It's Hallicrafters
MODEL S-31A (not illustrated)
High Fidelity 25-Watt Amplifier
for use with FM/AM Model S-31.
Price $49.50.
RADIO COMPASS
(Model S-30)
Price $89.50.
THE SKY BUDDY
(S-19R)
Tunes from 550 kc. to
44 mc. Price $29.50.
MARINE
RADIOPHONE
(Model HT-11)
Price $149.50.
MARINE
RADIOPHONE
(Model HT-12)
Price $390.00.
FREQUENCY
STANDARD
(Model HT-7)
Price $29.50.
25-WATT PHONE AND
CW TRANSMITTER
(Model HT-6)
Price $99.00.
MODEL RSC-1—Tunes from 110 kc. to 165
mc. (1.82 to 2730 meters). Price $450.00.
NEW FM/AM RADIO RECEIVING STATION
(Model RSC-2) with 25-Watt High Fidelity
Amplifier. Price $140.00.
THE
SKYRIDER 32
(Model SX-32)
Tunes from 500
kc. to 40 mc.
100-Watt Transmitter
Price $199.50.
the hallicrafters co.
CHICAGO, U. S. A.



background noises were found to duplicate normal operation. The following morning the set was pressed into service, and operated continuously for 53½ station hours. The terminal voltage dropped from 221 to 219 volts as the generator heated when carrying full load. The log sheets of the previous week revealed that the transmitter voltage varied from 217 to 224 volts under identical loading.

Several tests were made with a short wave receiver to determine if any disturbance was being transmitted by the diesel-electric set. Checks were made over the entire short wave band but no interference could be detected.

Listed as advantages of the diesel-electric power unit by T. A. Giles, engineer in charge, are the steady voltage and continuity of performance of which the unit is capable, either as a stand-by or prime power source. Moreover, electric power was produced at a cost less than of $0.01 per kwh with the set burning 2¾ gallons of fuel per hour at a cost of $0.07 per gal.

• • •

Television Floodlighting

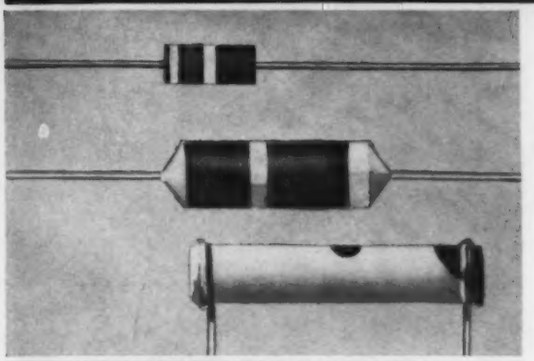
A NEW FLOODLIGHT producing illumination of daylight intensity without extreme heat and having application in the television field has been developed under the direction of A. F. Diekerson of the General Electric Company.

At equal room temperatures, maintained by air conditioning, the heat from three 1-kw mercury lamp units is only about 25 per cent of that from general service incandescent lamps giving comparable illumination. More than half of the heat developed by the mercury vapor lamp is carried away by a water cooling system.

Floodlight unit using three mercury vapor lamps. Because of high intensity and lack of heat, this lighting finds application in black and white television studio work

Although each of the three mercury vapor lamps is smaller than a cigarette, when combined in their appropriate reflector they produce the equivalent of 750 foot-candles over an area of approximately 100 square feet. This is approximately equivalent to the illumination out of doors on a reasonably fair day.

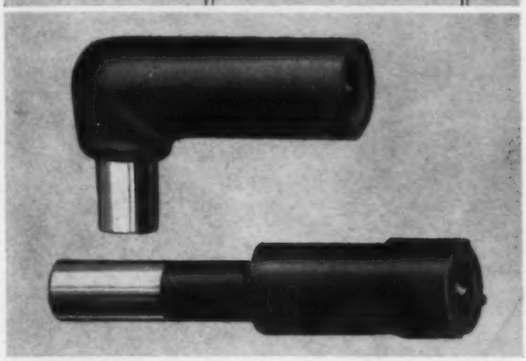
USE these dependable ERIE PRODUCTS



RESISTORS

for dependable operation

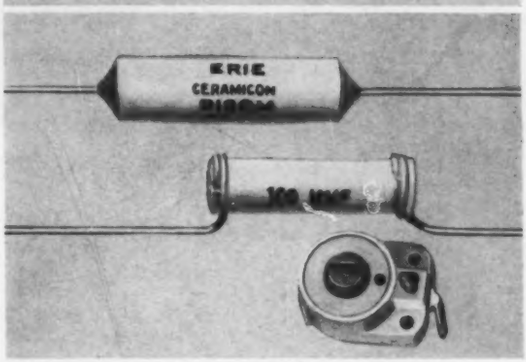
Erie Resistors give uniformly superior results in all standard tests for load, voltage, humidity and noise. They can be used in any part of the circuit without changing excessively in value. Erie Resistors are made in plain, insulated and hot molded types in sizes and ratings that cover practically all requirements.



SUPPRESSORS

to eliminate ignition noise

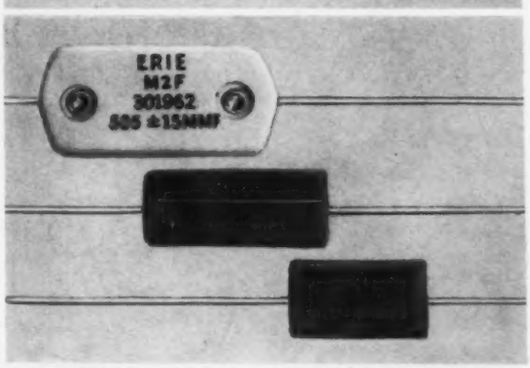
The low voltage coefficient of Erie Suppressors makes possible efficient suppression of high frequency spark discharges without using high resistance values that decrease engine efficiency. Made in several styles to fit all standard types of spark plugs and distributors.



CERAMICONS REG. U.S. PAT. OFF.

to compensate for temperature drift

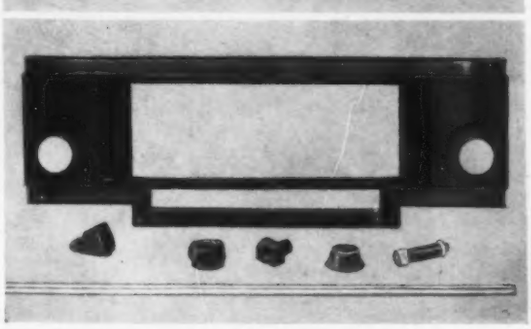
These fixed silver-ceramic condensers can be supplied with any desired temperature coefficient between —.00068 and +.00012/°C, in capacities up to 1100 mmf. Ceramicon Trimmers are available with 0, —.0003 and —.0005/°C temperature coefficient in capacities from 1.5 mmf. to 110 mmf. The temperature characteristics of all Ceramicons are definite and retraceable.



SILVER MICAS

to prevent condenser capacity drift

These condensers which have a temperature coefficient of only +.000025/°C, are ideal for applications where the utmost in stability is desired. Erie Silver Mica Condensers are made in capacities from 15 mmf. to 2500 mmf.



CUSTOM MOLDED PLASTICS

Erie has complete facilities for designing, engineering and molding plastic bezels, knobs, push buttons, and decorative trim by the injection and extrusion processes. Erie "Three Dimensional Plastics" makes possible unusual color combinations and three dimensional effects.

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Our regular stock includes over 100 standard resistor sizes—flat and tubular—from 4 to 400 watts, and 9 standard size rheostats from 10 to 500 watts—ready for quick delivery whether your needs be standard or special.

Our engineering service—as resistor specialists—is at your command. Our cooperation is offered to collaborate with you in meeting your needs most economically.

May we consult with you on your next order?

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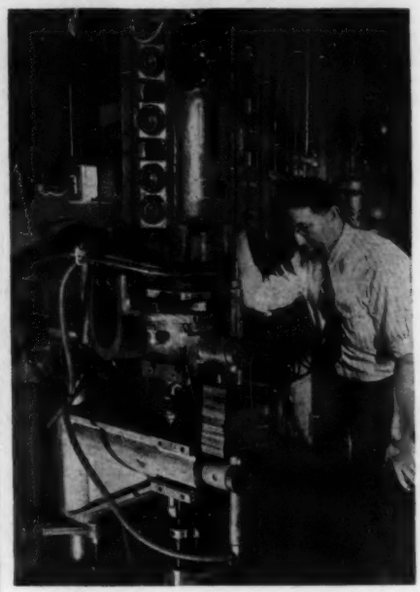
Resistors • Rheostats • Radio Frequency Reactors
Power Line Chokes • Line Voltage Reducers
Custom-made resistance devices of all types

Pulsation Welding

ONE OF THE MANY recent advances in resistance welding has permitted the temperature of the weld to be equalized across the entire assembly of 199 plates of 1/32-inch low carbon steel, making a satisfactory weld of all the multiple sheets. The method of pulsation welding has been developed by J. H. Redmond of the General Electric Works Laboratory at Schenectady. The photograph shows Mr. Redmond preparing the sheets for the pulsation weld.



Almost 200 individual sheets of steel are welded together by J. H. Redmond using his method of pulsation welding

While no practical need is seen at this time for such large scale welding of pieces, present day requests are diverse and varied and at any moment a request may come for welds of this type. At any rate, it is interesting to know that electronic developments make possible, for national defense or otherwise, welds of 199 pieces at one time—and this is by no means the limit.

• • •

G. E. Builds Electron Microscope

THE ELECTRON MICROSCOPE plays an important part in modern research where material must be examined at magnifications exceeding those possible with the optical microscope. Latest manufacturer, to come to our attention, of the several electron microscopes which are now available in this country, is the General Electric Company. Dr. Ralph P. Johnson of the Research Laboratories at Schenectady built the microscope camera which will be used in modern research analysis.

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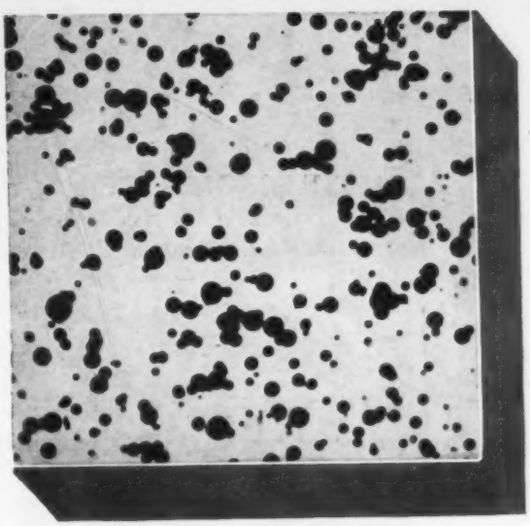

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Brush Crystal Soundcell All Purpose Microphone Type BR2S

Brush Crystal "Sound Cell" All Purpose Microphone Type BR2S

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BRUSH Crystal PRODUCTS

THE BRUSH DEVELOPMENT COMPANY

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Amplifier Drives Constant Speed Motor

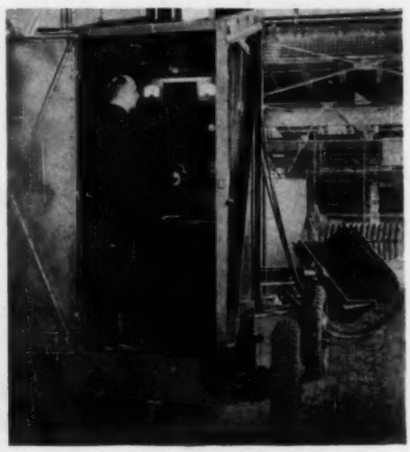
IT IS COMMON PRACTICE among radio and sound men to use the 60-cycle power line as a secondary standard of frequency for purposes of modulation or for measurement and timing. The procedure has recently been exactly reversed and a precision 60-cycle tone generator is utilized to drive a ½-kw electric motor through the medium of a high powered audio-frequency amplifier. The purpose of this arrangement is to provide mechanical driving power of absolutely constant speed.

In this apparatus a 60-cycle audio frequency standard generator capable of maintaining its frequency constant to within one part in one hundred thousand, provides the source of excitation. The output of the generator is fed into an amplifier capable of delivering 500 watts of undistorted output and this amplifier supplies the driving power for the synchronous motor.

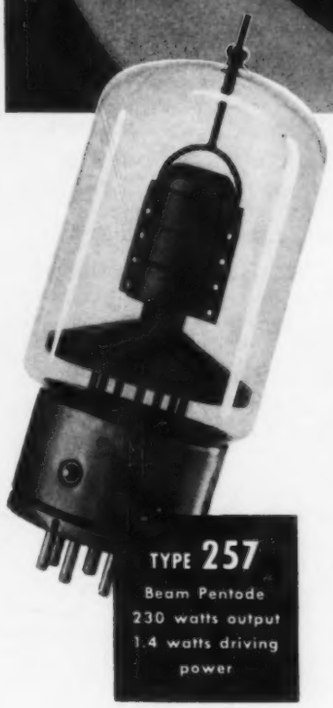
The design of this system is the development of the research section of the propeller division of the Curtiss-Wright Corporation to meet the requirements of certain critical test applications in their plants. Actual equipment was built by the Transformer Corporation of America whose engineers collaborated with Curtiss-Wright engineers in design details.

• • •

TRUCK-MOUNTED INDUSTRIAL RADIOGRAPHIC UNIT



To check the perfection of castings and welded parts which go into its products, G.E. engineers have developed this mobile x-ray equipment. The radiographic equipment may be moved about to examine the construction of equipment and discover flaws which might cause trouble at a later date if the defective casting were placed in service



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Every GAMMATRON tube is backed by the experience, reputation, and engineering ability of Heintz and Kaufman Ltd., builders of the original tantalum-element tubes over thirteen years ago. Today the leadership of the pioneer is evident in the HK-257 GAMMATRON. A tantalum beam tube of amazing UHF capabilities and very low driving requirements.

This leadership, background, and engineering ability is available to you through GAMMATRON tubes to make the solutions of your transmitting problems easier and more economical. Correspondence is invited.

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Kester Rosin-Core Solder is standard for every electrical and radio use, just as other Kester Cored Solders meet various other exacting industrial requirements. Kester offers an endless variety of alloys, fluxes, core-sizes and strand-sizes—all in the convenient flux-core form, that makes for fast, neat workmanship and more satisfactory plant operation.

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Program of Technical Papers

MONDAY, JUNE 23

10:00 A. M.—12:30 P. M.

"Photographic Analysis of Television Images," by D. G. Fink, *Electronics*, McGraw-Hill Publishing Company, New York, N. Y.

"Industrial Electronic Applications," by R. Powers, Electronic Control Corporation, Detroit, Mich.

"A Radio-Frequency Device for Detecting the Passage of a Bullet," by C. I. Bradford, Remington Arms Company, Inc., Bridgeport, Conn.

"Mobile Television Equipment," by R. L. Campbell, R. E. Kessler, R. L. Rutherford, and K. U. Landsberg, Allen B. Du Mont Laboratories, Inc., Passaic, N. J. (with demonstration).

2:30 P.M.-5:00 P.M.

"Ultrahigh-Frequency Loop Antennas for Frequency-Modulation Broadcasting," by Andrew Alford, A. G. Kandoian, and R. A. Hampshire, International Telephone Development Company, Inc., New York, N. Y.

"A Turnstile Antenna for Ultrahigh-Frequency Broadcasting," by G. H. Brown and J. Epstein, RCA Manufacturing Company, Inc., Camden, N. J.

"Frequency Modulation for Emergency Communication," by F. T. Budelman, F. M. Link Company, New York, N. Y.

"A New Frequency-Modulation Transmitter," by N. C. Olmstead and A. A. Skene, Bell Telephone Laboratories, Inc., New York, N. Y.

"An F-M Station Monitor," by H. R. Summerhayes, Jr., General Electric Company, Schenectady, N. Y.

"Phase Distortion in Frequency-Modulation Systems," by N. I. Korman, RCA Manufacturing Company, Inc., Camden, N. J.

2:30 P.M.-5:00 P.M.

"Control of Night Error in Airplane Direction Finding," by H. Busignies, International Telephone Development Company, Inc., New York, N. Y.

"A Method of Changing the Frequency of a Complex Wave," by E. L. Kent, C. G. Conn, Ltd., Elkhart, Ind.

"A New Air-Cooled 5-Kilowatt Broadcast Transmitter," by F. W. Fischer, Westinghouse Electric and Manufacturing Company, Baltimore, Md.

WHAT HAPPENS TO RELAY CONTACT ACTION AT *40,000* FEET?

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In addition to many aviation units, Dunco offers a complete line for ordinary or special industrial requirements—plus a specialized engineering service in adapting relays 100% to your particular requirements. The Dunco General Catalog or the new Dunco Aviation Relay Bulletin will gladly be sent upon request.

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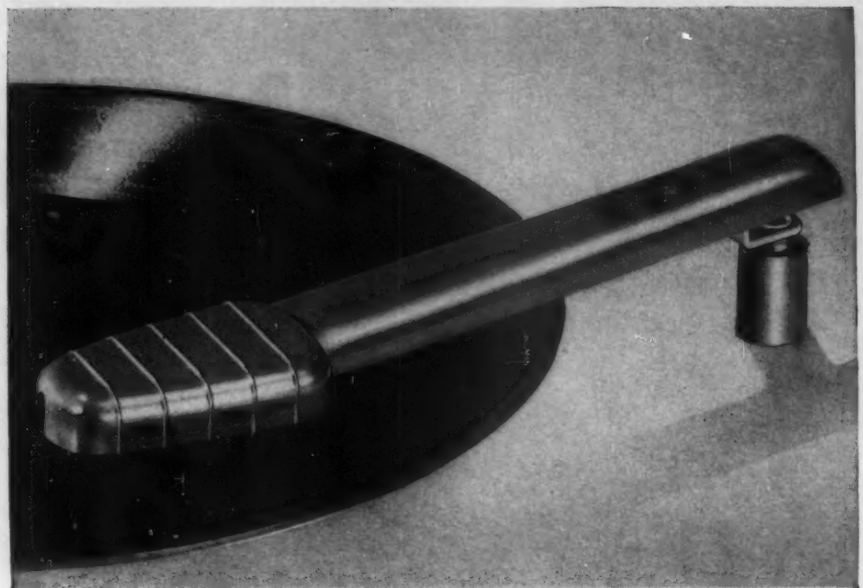

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Light weight with low pressure—minimizes surface noise and greatly increases record life . . . only 40 grams pressure.

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Special Long Life Needle—plays thousands of records before changing is necessary. Needle is easily replaceable.

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"Optimum Current Distributions on Vertical Antennas," by Lincoln La Paz and G. A. Miller, Ohio State University, Columbus, Ohio, and the National Research Council, Ottawa, Ont., Canada, respectively.

"Short-Wave Spread-Band Receiver Circuits," by D. E. Foster and Garrard Mountjoy, Radio Corporation of America, License Division Laboratory, New York, N. Y.

"Factory Alignment Equipment for F-M Receivers," by H. E. Rice, Stromberg-Carlson Telephone Manufacturing Company, Rochester, N. Y.

"The Full-Wave Voltage-Doubling Rectifier Circuit," by D. L. Waidelich, University of Missouri, Columbia, Mo.

7:00 P.M.-9:30 P.M.

"Electronics in Medicine," by members of staff, Harper Hospital.

TUESDAY, JUNE 24

9:30 A.M.-11:30 A.M.

"Transmission of an Electromagnetic Wave by a Row of Equidistant Similar Plates."

• • •

FOURTEEN-FOOT TEST TUBE

This towering apparatus is used in the General Electric Co's. research laboratory at Schenectady for the separation of atoms of different weights by thermal diffusion. Two concentric glass tubes, 14 feet long with a gold wire passing through the center of the inner tube, constitute the essential elements of the system. The outer tube is used to maintain the temperature of the inner tube constant, by passing steam through it. When the gold wire is heated, the lighter atoms rise and the heavier atoms drop to the lower portion of the tube

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Electric Current Flows Safely to Ships in Dry Dock

thanks to PHENOLITE in "Ship-to-Shore" connectors

PHENOLITE perfectly provides essential insulation for "ship-to-shore" connectors. Manufactured by Russell & Stoll Company.

WHEN ships are in dry dock or tied up for repairs, "ship-to-shore" connectors carry the electrical current for power and light on board.

These connectors have to be made of a material that will withstand the most vigorous treatment. Housed in heavy bronze enclosures is the heart of these connectors — insulating supports for the contact members, made of Phenolite, laminated Bakelite. A wide variety of housing designs are available to suit individual requirements but the important insulating task in all of them, is assigned to Phenolite. The selection of Phenolite for this particular job is explained by the fact that it resists the corrosive action of harbor gases; weather has no effect on it; it is unbreakable . . . it does not split, splinter or rust . . . and it has exceptional dielectric strength. Phenolite, in short, can "take it."

This use of Phenolite is but one of countless applications where, because of its singular characteristics, it makes unusual products possible. National's technical men are constantly working with engineers in industry on problems where Phenolite or National Vulcanized Fibre may be used advantageously. It may be that our technical research service may be of assistance to *you*. We invite your inquiry.

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OHMITE RESISTANCE UNITS
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because their compact design and vitreous-enameled construction assure permanently smooth, closely-graduated control and long operating life.

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because they stand the gaff under severe operating conditions—and prevent costly breakdowns! They re wire-wound and vitreous-enameled.

We Use OHMITE Tap Switches

because of their compact ceramic construction, high current ratings, silver-to-silver contacts, and special slow-break action!

OHMITE Resistance Units are widely used year after year in all types of applications under all types of operating conditions —for control of electronic devices, of radio and laboratory equipment, of signal and supervisory circuits, of motor speed, of generator fields, of heat and light. They are available in many types and sizes in stock and special units to meet the specific requirement of each application.

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by Hillel Poritsky, General Electric Company, Schenectady, N. Y.

"The Field Theory Approach to Non-uniform Transmission Lines," by Simon Ramo, General Electric Company, Schenectady, N. Y.

"A Mechanical Calculator for Directional Antenna Patterns," by W. G. Hutton, WGAR, Cleveland, Ohio.

"Theory of Radial D-C Space-Charge Flow Between Concentric Cylinders," by W. G. Dow and A. B. Bronwell, University of Michigan, Ann Arbor, Mich., and Northwestern Technological Institute, Evanston, Ill., respectively.

"Some Simplified Methods of Determining the Optical Characteristics of Electron Lenses," by Karl Spangenberg and L. M. Field, Stanford University, Santa Clara, Calif.

9:30 A.M.-11:30 A.M.

"Deionization Considerations in a Harmonic Producer Employing a Gas Tube Switch," by W. G. Shepherd, Bell Telephone Laboratories, Inc., New York, N. Y.

"Design and Development of Three New Ultrahigh-Frequency Transmitting Tubes," by C. E. Haller, RCA Manufacturing Company, Inc., Harrison, N. J.

"New Small Ultrahigh-Frequency Receiving Tubes," by L. B. Curtis, RCA Manufacturing Company, Inc., Harrison, N. J.

"Trends in Receiving Tube Design," by R. L. Kelly, RCA Manufacturing Company, Inc., Harrison, N. J.

"The Effects of Contact Potentials on the Characteristics of Vacuum Tubes," by G. D. O'Neill, Hygrade Sylvania Corporation, Salem, Mass.

"A Method of Calculating the Performance of Self-Biased Plate-Modulated Amplifiers," by R. I. Sarbacher, Illinois Institute of Technology, Chicago, Ill.

WEDNESDAY, JUNE 25

9:30 A.M.-12:00 Noon

"The Relative Sensitivities of Television Pick-Up Tubes, Photographic Film, and the Human Eye," by Albert Rose, RCA Manufacturing Company, Inc., Harrison, N. J.

"Measurement, Analysis, Synthesis, and Evaluation of the Square-Wave Response of Television Apparatus," by R. D. Kell, A. V. Bedford, G. L. Fredendall, and H. N. Kozanowski, RCA Manufacturing Company, Inc., Camden, N. J. (with demonstration).

"Observations of Frequency-Modulation Propagation on 26 Megacycles," by M. G. Crosby, R.C.A. Communications, Inc., Riverhead, L. I., N. Y.

"Counter Circuits and Their Applications," by H. B. Deal, Radio Corporation of America, License Division Laboratory, New York, N. Y.

"Orthicon Portable Television Equipment," by M. A. Trainer, RCA Manufacturing Company, Inc., Camden, N. J.

Free TIME-SAVER FOR BROADCAST ENGINEERS

This new booklet is designed for broadcast engineers and will be sent to them in the regular Graybar mailing. If your name is not on this mailing list—or if you should wish additional copies—send the coupon.

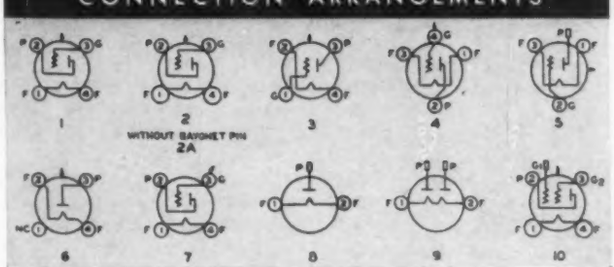
Characteristics of 141 Western Electric vacuum tubes

. . . at your finger tips

Now you can spot the tubes you need with a glance at the new Western Electric General Bulletin on Vacuum Tubes.

Characteristic data arranged in tabular form give the story in a nutshell . . . and, referring to your data sheets, you quickly get the full details.

. . . AND COMPLETE TERMINAL AND CONNECTION ARRANGEMENTS



Keyed directly to each of the 141 tubes listed are engineering drawings of terminal arrangements. Another time-saver!

Western Electric

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New Books

Grundlagen Und Kennlinien Der Elektronenröhren

BY H. ROTHE and W. KLEEN *Principles and Characteristics of Electron Tubes —320 pages, 196 illustrations. Akademische Verlagsgesellschaft, Leipzig. Price—20 RM bound.*

Elektronenröhren als Anfangsstufen—Verstärker

BY H. ROTHE and W. KLEEN, *Electron Tubes as Voltage Amplifiers—297 pages —197 illustrations. Akademische Verlagsgesellschaft, Leipzig. Price 19 RM bound.*

THESE BOOKS ARE THE FIRST two in a series of five volumes on tubes and amplifiers in a projected Radio Engineering Library. Electron tubes as output and transmitting amplifiers, electron tubes as oscillators and rectifiers and the properties of electron tubes at high frequencies by the same authors, are to comprise the remainder of the series. It is the purpose of the authors in these five volumes, to cover the theory and applications of amplifier tubes, including high-vacuum rectifiers and transmitting amplifiers.

The first volume is considerably more restricted than its title indicates, since only amplifier tubes are discussed and a considerable number of other types of electron tubes are omitted. The first portion of the book deals with the basic physical principles and includes sections on the laws of space charge phenomena, static potential fields, electron trojectories and current distribution and chapters on transit times and secondary emission. Noteworthy is the chapter on space charge in the grid-anode space of a tube which discusses the requirements for the formation of a potential minimum or a virtual cathode as well as the critical values of current density. Relations of importance from the standpoint of practical application such as current potential characteristics, current distributions and space potential relations as functions of current density, electrode potentials and electrode spacings are treated in considerable detail. The second part of the book is devoted to a detailed discussion of static characteristics. It includes chapters on diodes, ideal and practical triodes, variable-mu characteristics, tetrodes, pentodes, current distribution control, hexodes, converters and octodes. While it is shown that even the characteristics of complicated multi-grid tubes are subject to analysis on the basis of fundamental principles, no specific illustrations of such tube design are given. The remainder of the book covers a few miscellaneous topics including the fine structure of tube characteristics, a few special tube types and a brief discussion of amplifier tube construction. A considerable part of this volume is a consolidation of material published by the authors during the past few years in the Telefunken-Röhre.

The volume on voltage amplifiers, is arranged into three sections. The first discusses the fundamental problem of amplification and includes chapters on both linear and non-linear theory of amplification, non-linear distortion in radio frequency amplifiers, theory of mixing and the measurement of non-linear distortion effects. The second portion covers the conventional amplifier circuits, as well as mixing circuits, automatic volume control and dynamic control of audio amplifiers. The remainder of the book is devoted to noise phenomena in tubes and circuit elements which set a limit to attainable amplification and includes chapters on tube noise and microphonics. Insofar as possible, throughout this volume, the center of interest lies in the tube itself and external circuit elements are discussed only to the extent necessary for a proper understanding of the action of the tube in the circuit. Thus, no attempt is made to include complete designs of specific types of amplifier circuits.

Both books are clearly written, logically arranged and have well-chosen and executed diagrams. A bibliography of the more important and recent publications is included at the end of each chapter.

While both books may be highly recommended, the material of the second volume is well covered by several American books. The volume on tubes will be useful to tube designers and others interested in an up-to-date treatment of basic principles and characteristics of tubes. The completed series will undoubtedly comprise a valuable set of reference books on the theory and application of amplifier tubes.—HAROLD HEINS

Electromagnetic Theory

BY J. A. STRATTON, *Associate Professor of Physics, Massachusetts Institute of Technology. Published by McGraw-Hill Book Company, New York, N. Y., 1941. 615 pages, 116 illustrations. Price $6.00.*

THIS IS NOT A SIMPLE BOOK, nor one intended for the engineer who has only a casual interest in the physical basis of electromagnetic phenomena. In the first place, a working knowledge of vector analysis is assumed, including familiarity with the symbolism of the curl and the divergence of a vector, use of which is made on the second page of the book. But if these prerequisites are available, the reader will find in the book a refreshing down-to-earth attitude. The mathematical symbolism is translated, in nearly every case, into a physical picture, using electrical concepts. The development of the equations is complete and enough words are included to make following the steps as easy as the subject allows. But the book is obviously best fitted for the student who has just finished a comprehensive course in vector calculus.

The book is thorough, rigorous, and is written by a man used to teaching the subject to electrical engineering students. Hence it has a practical and reasonable point of view toward the engineering approach. While the book is an advanced text on physics, it is admirably suited to the mathematically prepared engineer who aspires to a comprehensive understanding of wave propagation effects and the other microscopic aspects of electromagnetics. The M.K.S. system of units, so useful in translating from physical theory to engineering practice, is employed throughout. The Chapters are: The Field Equations; Stress and Energy; the Electrostatic Field; the Magnetostatic Field; Planes Waves; Cylindrical Waves; Spherical Waves; Radiation; and Boundary Value Problems. Since, as the author states, a complex theory can be learned only by working problems, several are appended to each chapter. The book is best used by students in school, but it should prove useful as a reference to individuals who have the proper mathematical background. It is certainly one of the outstanding treatments of the subject in print today.—D.G.F.

Getting Acquainted with Radio

BY ALFRED MORGAN. *D. Appleton-Century Co., New York, 1940, 285 pages, numerous illustrations. Price, $2.50.*

THIS BOOK by the author of several other elementary technical books is intended for the person making his first acquaintance with the science of radio. As such it is excellent. The subject matter is developed in such a manner and from a practical viewpoint so that little trouble will be encountered by the average non-technical reader.

Elementary theory is presented in simple understandable language and a great number of the components of radio equipment are described. Instructions for constructing a number of simple receivers and transmitters are given.—C.W.

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TUBES

An index of all tubes listed in this department is presented as well as new types registered in April and a number of older types

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112-A	Detector Amplifier Triode, $\mu = 8.5$	June 41	118

Filament Types (Other than dry battery)

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2A4G	Thyratron	May 40	65
2V3G	Half-Wave Rectifier, $I_{dc} = 2$	Mar 40	69
2W3	Half-Wave Rectifier, $I_{dc} = 55$	Apr 40	92
2W3GT	Half-Wave Rectifier, $I_{dc} = 55$	Dec 39	54
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2X3G	Half-Wave Rectifier, $I_{dc} = 125$	Aug 40	69
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5V4G	Full-Wave Rectifier, $I_{dc} = 175$	Nov 40	72
5W4	Full-Wave Rectifier, $I_{dc} = 100$	Jan 41	70
5W4G	Full-Wave Rectifier, $I_{dc} = 100$	Aug 40	68
5W4GT	Full-Wave Rectifier, $I_{dc} = 90$	Nov 39	73
5X3	Full-Wave Rectifier, $I_{dc} = 110$	Apr 40	96
5X4G	Full-Wave Rectifier, $I_{dc} = 225$	Sept 40	71
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Unipotential Cathode Types

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2A6	Doudiode, High-mu Triode, $\mu = 100$	Feb 41	68
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2G5	Tuning Indicator	Mar 41	80
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6A6	Class B Twin Triode, Amplifier, $\mu = 35$	Nov 40	68
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6A8G	Pentagrid Converter, $g_c = 550$	Nov 40	66
6A8GT	Pentagrid Converter, $g_c = 550$	June 40	74
6AB5	Tuning Indicator	July 40	58
6AB6G	Direct-Coupled Power Amplifier, $P_o = 3.5$	Aug 40	70
6AB7 (M)	R-F Pentode, rco, $g_m = 5000$	Feb 40	55
6AC5G	PA Triode, $P_o = 3.7$	July 40	58
6AC5GT	High-mu PA Triode, $\mu = 125$	June 40	74
6AC6G	Direct-Coupled Power Amplifier, $P_o = 3.8$	Aug 40	67
6AC6GT	Triple-Twin PA, $P_o = 3.6$	June 40	72
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6AE5GT	Triode, $\mu = 4.2$	Nov 39	73
6AE6G	Single-Grid, Twin Plate Control Tube	May 40	64

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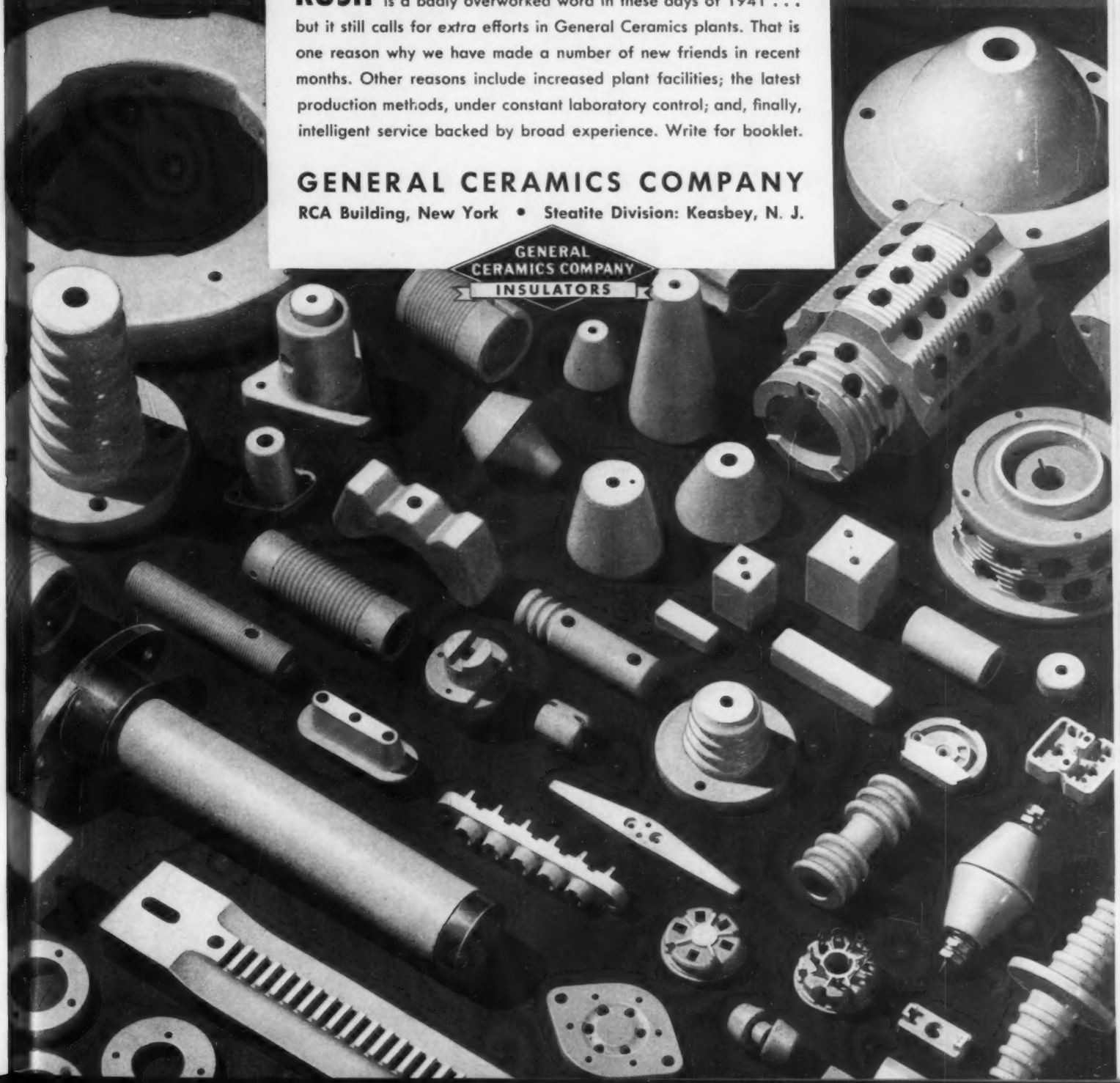
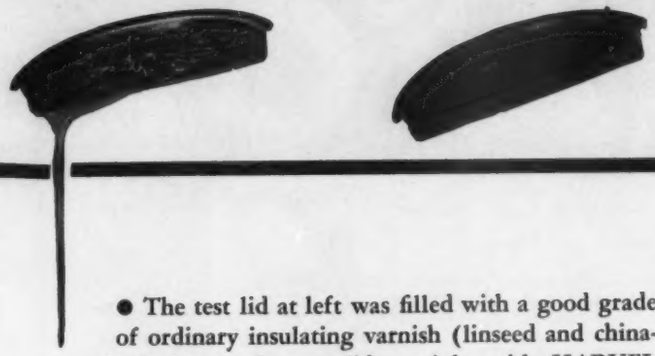


TWO LIDS THAT TEACH A LESSON



● The test lid at left was filled with a good grade of ordinary insulating varnish (linseed and china-wood oil base), the test lid at right with HARVEL 612-C, the sensational phenol-aldehyde synthetic resin base insulating varnish made from Cashew Nut Shell Liquid. The lid with ordinary varnish was baked for two weeks at 220°F, but the lid with HARVEL 612-C varnish was only baked for sixteen hours. Then they were each cut in half—and look at what happened!

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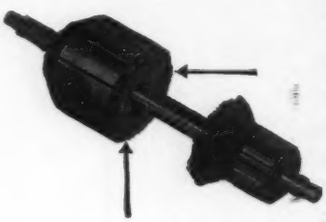

HARVEL 612-C cannot soften or throw out and when cured, it is neither affected by acids, nor disintegrated by mild or concentrated alkali solutions. It is highly resistant to transformer and lubricating oil and maintains its insulating qualities at elevated temperatures far better than ordinary varnishes. It may be applied in any of the usual ways and because of its excellent dip-tank stability, there is no storage loss.

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Representatives in 20 Principal Cities

Type	Function	Issue	Page
6AE7GT	Double Driver Triode (common plate), μ = 14	July 40	57
6AF5G	Triode, μ = 7.4	Feb 40	52
6AF6G	Tuning Indicator,	May 40	64
6AF7G fs	Tuning Indicator,	Feb 40	51
6AG6G	PA Pentode, P_o = 3.75	Apr 40	96
6AG7 (M)	Beam Amplifier, g_m = 7700	Feb 40	51
6AH7GT	Twin Triode, μ = 16	Apr 41	84
6AL6G	Beam Power Amplifier, P_o = 6.5	Nov 39	71
6B4G	Triode Power Amplifier, P_o = 3.2	Sept 40	67
6B5	Direct-Coupled PA, P_o = 4	Nov 40	64
6B6G	Duplex-Diode High-mu Triode, μ = 100	Oct 40	68
6B7	Double Diode, Pentode, g_m = 1125	Mar 41	79
6B8	Duodiode Pentode, g_m = 1325	Sept 40	69
6B8G	Duodiode Pentode, g_m = 1125	Sept 40	68
6B8GT	Duodiode, Pentode, rco, g_m = 1325	July 40	57
6C5	Detector Amplifier Triode, μ = 20	Jan 41	72
6C5 (G)	Detector Amplifier Triode, μ = 20	Jan 41	72
6C5GT	Triode, μ = 20	Dec 39	53
6C6	Triple-Grid Detector Amplifier, sco, g_m = 1225	May 41	76
6C7	Duo-Diode Triode μ = 20	May 41	73
6C8G	Double, Triode, μ = 36	Aug 40	69
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6D5 (G)	Power Output Triode, P_o = 1.4	Jan 41	68
6D6	Triple-Grid, Super-Control Amplifier, g_m = 1600	Mar 41	80
6D7	Triple-Grid Detector Amplifier, sco, g_m = 1225	May 41	73
6D8G	Pentagrid Converter, g_c = 550	Sept 40	69
6E5	Electron Ray Tube	Oct 40	66
6E6	Double Triode Power Amplifier, P_o = 1.6	Jan 41	66
6E7	Triple-Grid, Super-Control Amplifier, g_m = 1600	May 41	72
6E8G fs	Triode-Hexode, g_c = 630	Dec 39	53
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6F5GT	High-mu Triode, μ = 100	June 40	76
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6F6 (G)	Power Amplifier Pentode, P_o = 3.2	Jan 41	66
6F6 (GT)	PA Amplifier, P_o = 3.2	Mar 40	62
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6H6	Twin Diode	Nov 40	70
6H6G	Twin Diode	Nov 40	70
6H6GT	Double Diode	June 40	78
6H8G fs	Double Diode Pentode, g_m = 2400	Dec 39	57
6J5	Detector Amplifier Triode, μ = 20	July 40	57
6J5 (G)	Detector Amplifier Triode, μ = 20	Jan 41	71
6J5GT	Detector Triode Amplifier, μ = 20	June 40	78
6J7	Triple-Grid Detector Amplifier, g_m = 1225	Nov 40	70
6J7G	Triple-Grid Detector Amplifier, g_m = 1225	Nov 40	70
6J7GT	Triple-Grid Detector Amplifier, g_m = 1225	June 40	80
6J8G	Triode-Heptode Converter, g_c = 290	July 40	58
6K5 (G)	High-mu Triode, μ = 70	Jan 41	71
6K5GT	High-mu Triode, μ = 70	June 40	80
6K6G	PA Amplifier Pentode, P_o = 3.4	Sept 40	67
6K6GT	PA Pentode, P_o = 3.4	June 40	80
6K6 (MG)	Power Amplifier Pentode, P_o = 3.4	Oct 40	68
6K7	Triple-Grid, Super-Control Amplifier, rco, g_m = 1450	Jan 41	68
6K7 (G)	Triple-Grid, Super-Control Amplifier, rco, g_m = 1450	Jan 41	68
6K7GT	Triple-Grid Super-Control Amplifier, rco, g_m = 1450	June 40	80
6K8	Triode-Hexode Converter, g_c = 350	July 40	60
6K8G	Triode-Hexode Converter, g_c = 350	May 40	64
6K8GT	Triode-Hexode, g_c = 350	Feb 40	55

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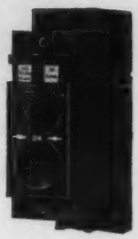
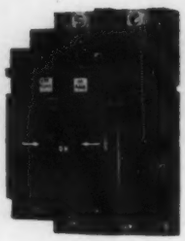


ONE POLE



TWO POLE

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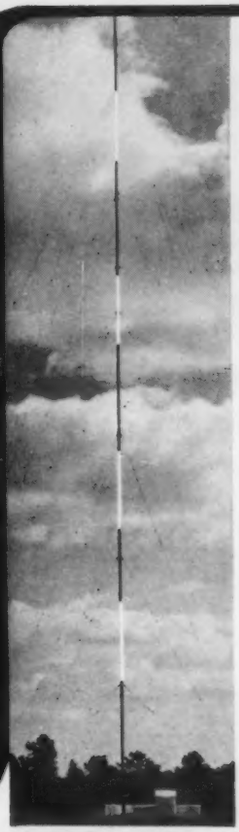
Type	Function	Issue	Page
6L5G	Detector Amplifier Triode, $\mu = 17$	Sept 40	68
6L6	Beam Power Amplifier, $P_o = 10.8$	Jan 41	71
6L6 (G)	Beam Power Amplifier, $P_o = 10.8$	Feb 41	68
6L7	Pentagrid Mixer Converter, $g_o = 375$	Oct 40	66
6L7 (G)	Pentagrid Mixer Converter, $g_o = 375$	Jan 41	71
6M6G	PA Pentode, $P_o = 4.4$	Apr 40	96
6M8GT fs	Diode, Triode, Pentode, $g_m = 1900$	Nov 39	72
6N5	Tuning Indicator	Sept 40	67
6N6	Dynamic Coupled PA, $P_o = 4$	Sept 40	68
6N6 (MG)	Dynamic Coupled PA, $P_o = 4$	Oct 40	70
6N7GT	Twin-Triode, $\mu = 35$	Nov 40	64
6N7 (MG)	Twin Triode Amplifier, $P_o = 10$	Oct 40	70
6P5G	Detector Amplifier Triode, $\mu = 13.8$	July 40	57
6P5GT	Triode, $\mu = 14$	Feb 40	54
6P7G	Low-mu Triode, R-F Pentode, $g_m = 1100$	May 41	74
6P8G	Triode-Hexode Converter, $g_o = 650$	Apr 40	92
6Q6G	Diode, High-mu Triode, $\mu = 65$	Sept 40	67
6Q7	Double-Diode, High-mu Triode, $\mu = 70$	Feb 41	68
6Q7GT	Duodiode, High-mu Triode, $\mu = 70$	June 40	80
6Q7 (MG)	Duplex Diode, High-mu Triode, $\mu = 70$	Oct 40	69
6R6G	R-F Pentode, rco, $g_m = 1450$	July 40	59
6R7G	Double Diode, Triode, $\mu = 16$	Nov 40	68
6R7GT	Double Diode, Triode, $\mu = 16$	Dec 39	53
6R7 (M)	Double Diode, Triode, $\mu = 16$	Oct 40	70
6S5	Tuning Indicator	Aug 40	66
6S6GT	R-F Pentode, rco, $g_m = 4000$	Apr 40	88
6S7	Triple-Grid Super-Control Amplifier, rco, $g_m = 1750$	July 40	60
6S7G	Triple-Grid, Super-Control Pentode, rco, $g_m = 1750$	Sept 40	67
6SA7	Pentagrid Converter, $g_o = 450$	Apr 40	92
6SA7GT	Pentagrid Converter, $g_o = 425$	Feb 40	55
6SC7	Twin Triode Amplifier, $\mu = 70$	Apr 40	93
6SD7GT	R-F Pentode, semi-rco, $g_m = 3600$	June 40	72
6SE7GT	R-F Pentode, sco, $g_m = 3400$	June 40	74
6SF5	High-mu Triode, $\mu = 100$	Apr 40	93
6SF5GT	High-mu Triode, $\mu = 100$	Jan 40	64
6SF7 (M)	Diode, Pentode, rco, $g_m = 2050$	May 41	69
6SG7	R-f Pentode, semi-rco, $g_m = 4000$	Apr 41	86
6SJ7	R-F Pentode, sco, $g_m = 1650$	Apr 40	93
6SJ7GT	R-F Pentode, sco, $g_m = 1650$	Jan 40	60
6SK7	R-F Pentode, rco, $g_m = 2000$	Apr 40	93
6SK7GT	R-F Pentode, rco, $g_m = 1650$	Jan 40	60
6SN7 GT	Twin Triode, $\mu = 20$	May 41	69
6SQ7	High-mu Triode, Double Diode, $\mu = 100$	Apr 40	93
6SQ7G	Double Diode, High-mu Triode, $\mu = 100$	Nov 39	73
6SQ7GT	Double Diode, High-mu Triode, $\mu = 100$	Jan 40	60
6SR7 (M)	Duodiode, Triode, $\mu = 16$	June 40	72
6SS7 (M)	Voltage Amplifier Pentode, $g_m = 1850$	June 41	110
6T5	Tuning Indicator	July 40	60
6T7G	Duodiode, High-mu Triode, $\mu = 65$	Aug 40	68
6U5-6G5	Tuning Indicator	Aug 40	66
6U6GT	Beam Power Amplifier, $P_o = 5.5$	Aug 40	65
6U7G	Triple-Grid Super-Control Amplifier, $g_m = 1600$	Sept 40	70
6V6	Beam Power Amplifier, $P_o = 4.5$	July 40	58
6V6G	Beam Power Amplifier, $P_o = 4.5$	Aug 40	68
6V6GT	Beam Power Amplifier, $P_o = 4.25$	Nov 39	69
6V7G	Duodiode Triode, $P_o = 0.350$	Sept 40	70
6W5G	Full-Wave Rectifier, $I_{dc} = 90$	Aug 40	68
6W6GT	Beam Power Amplifier, $P_o = 3.3$	Dec 39	55
6W7G	Triple-Grid Detector-Amplifier, sco, $g_m = 1225$	July 40	60

Look to Lingo

FOR TODAY'S OUTSTANDING ANTENNA ACHIEVEMENTS

Backed by the conviction that a better job can be done than has ever been done before, John E. Lingo & Son, Inc. is accomplishing outstanding results in the designing and construction of AM and FM radiators that set new performance standards for the broadcasting industry. Improved designs and exclusive patented features are responsible for their high efficiency, unexcelled stability and low maintenance costs.

As a result, for service and economy, LOOK TO LINGO!



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Solid facts and figures are available to you on numerous Lingo Vertical Tubular Steel Radiators now in service throughout this country and Canada. The widespread application and increasing acceptance of Lingo "Tube" Radiators are your assurance and proof that you can expect and get a full dollar's worth of performance for every dollar you invest. Buy on the basis of proved performance and enjoy the benefit of Lingo's:

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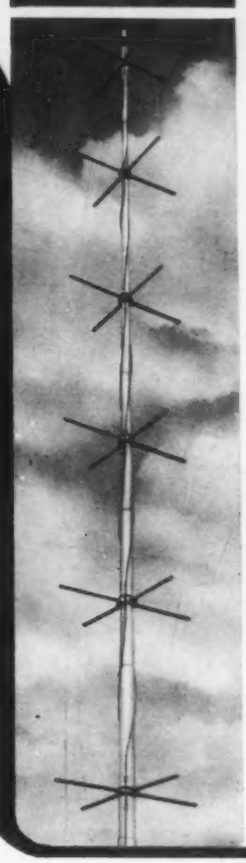
Our engineering staff will be pleased to supply you with technical details as they apply in your own case—without obligation, of course. In writing please state location, power and frequency of station.



LINGO FOR FM TURNSTILE RADIATORS

Already Installed! Already Proved! Now Available for Your Particular Use . . .

Here is the first and only Frequency Modulation antenna of its kind in the radio industry! The new, improved design is another step in Lingo's policy of leading in FM antenna development. This new turnstile antenna is the result of years of research and development. These features are important:

- **Antenna radiates a horizontal polarized signal with uniform circular field pattern.**
- **Antenna are custom built, and factory adjusted to the operating frequency, making no field adjustments necessary.**
- **Improved, simplified method of feeding and coupling.**
- **Turnstile elements fed by coaxial lines, no open turnstile wires used. Only one main transmission line required. Only two lines used between layers of elements.**
- **Available with 2, 4, 6, 8 or 10 layers of turnstile elements depending upon desired gain.**

Quotations now for stations up to 50 KW. include essential steel mounting pole, turnstile elements, coupling equipment, transmission lines feeding the elements, etc. (Climbing steps, lighting equipment and sleet melting units are also available as optional equipment.) Write today for complete facts and please indicate your proposed frequency, power and location.

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Seven-inch Bakelite case instrument with long (6 inch) scale.

The popular Bakelite case 3" panel instrument.

The 3", "surface mounting", Bakelite case instrument.

Particularly compact 2" instrument with narrow flanged metal case.

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Another distinctive Bakelite case design in a 4½" rectangular instrument.

Beauty and grace—long scale with compactness in this Bakelite case 4½" instrument.

How much does a FINE instrument cost?

IN electrical instruments, as in watches, the finer the movement, the finer the instrument. And once it could be said that the finer the movement the higher the price of the instrument.

But that was before we placed the finest type of movement—a full bridge-type movement with soft iron pole pieces—in instruments that cost you no more than the ordinary kind.

How did we give you this more expensive type of construction in instruments that cost no more? In simple terms we did this by standardizing on this one type of movement and passing on to you the production economies effected by the standardization.

Examine a Simpson Instrument. Note the "quality look"—the outward evidence of extra value in every hidden detail. One inspection will convince you that a *fine* instrument costs no more than the ordinary kind.

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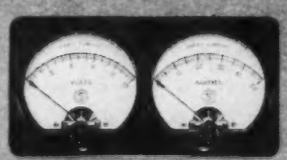

Neat duplex design for limited space requirements.

Simpson aircraft instrument in the familiar "Army and Navy" Case.

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INSTRUMENTS THAT STAY ACCURATE

Type	Function	Issue	Page
6X5	Full-Wave Rectifier, $I_{dc} = 70$	Nov 40	72
6X5GT	Full-Wave Rectifier, $I_{dc} = 70$	June 40	76
6X6G	Tuning Indicator	Aug 40	66
6Y5	Full-Wave, High-Vacuum Rectifier, $I_{dc} = 50$	June 41	111
6Y6G	Beam Power Amplifier, $P_o = 6.0$	July 40	60
6Y6GT	Beam Power Amplifier, $P_o = 3.6$	Jan 40	62
6Y7G	Double Triode PA, $P_o = 8.0$	Aug 40	67
6Z5	Full-Wave, High-Vacuum Rectifier, $I_{dc} = 60$	June 41	111
6Z6 (MG)	Full-Wave Rectifier, $I_{dc} = 50$	Oct 40	68
6Z7G	Twin Triode Power Amplifier, $P_o = 2.2$	July 40	59
6ZY5G	Full-Wave Rectifier, $I_{dc} = 40$	July 40	57
7A4 (GL)	Triode, $\mu = 20$	Feb 40	54
7A5 (GL)	Power Amplifier Pentode, $P_o = 1.9$	Jan 40	66
7A6 (GL)	Duodiode	May 40	63
7A7 (GL)	R-F Pentode, rco, $g_m = 2000$	Apr 40	95
7A7 (LM)	R-F Pentode, rco, $g_m = 2000$	Nov 39	75
7A8 (GL)	Octode Converter, $g_c = 600$	May 40	63
7B4	High-mu Triode, $\mu = 100$	Mar 40	63
7B5 (GL)	Power Amplifier Pentode, $P_o = 3.4$	Mar 40	69
7B5 (LT)	PA Pentode, $P_o = 4.5$	May 40	60
7B6 (GL)	Double Diode, High-mu Triode, $\mu = 100$	Mar 40	67
7B6 (LM)	Duo-Diode, High-mu Triode, $\mu = 100$	May 40	60
7B7 (GL)	R-F Pentode, rco, $g_m = 1700$	Apr 40	95
7B8 (GL)	Pentagrid Converter, $g_c = 550$	Mar 40	66
7B8 (LM)	Pentagrid Converter, $g_c = 550$	May 40	60
7C5 (GL)	Beam Power Amplifier, $P_o = 4.25$	Mar 40	66
7C5 (LT)	Beam Power Amplifier, $P_o = 5.5$	May 40	61
7C6GL	Duo-Diode, Triode, $\mu = 100$	Apr 40	95
7C7 (GL)	R-F Pentode, $g_m = 1300$	Feb 40	56
7E6 (GL)	Double Diode, Triode, $\mu = 16$	Feb 40	51
7E7 (GL)	Double Diode, Pentode, $g_m = 1300$	Dec 39	55
7F7 (GL)	Double Triode, $g_m = 2(1600)$	Dec 39	55
7G7/1232	R-F Pentode, sco, $g_m = 4500$	Mar 40	63
7H7 (GL)	R-F Pentode semi-rco, $g_m = 3800$	Oct 40	65
7J7 (GL)	Triode-Hexode Converter, $g_c = 310$	Nov 39	69
7L7 (GL)	R-F Pentode, sco, $g_m = 3100$	May 40	60
7N7 (GL)	Double Triode, $\mu = 20$	June 40	74
7Q7 (GL)	Pentagrid Converter, $g_c = 450$	Nov 39	71
7R7 (GL)	Duodiode, Pentode, rco, $g_m = 3200$	May 41	69
7V7 (GL)	R-F Pentode, $g_m = 5800$	Mar 41	77
7Y4 (GL)	Full-Wave Rectifier, $I_{dc} = 60$	Apr 40	95
7Z4 (GL)	Full-Wave Rectifier, $I_{dc} = 300$	Feb 41	67
WD-11	Triode Detector Amplifier, $\mu = 6.6$	Mar 41	77
WX-12	Triode Detector Amplifier, $\mu = 6.6$	Mar 41	77
12A5	Power Amplifier Pentode, $P_o = 3.4$	Apr 41	86
12A6 (M)	Beam Power Amplifier, $P_o = 2.5$	Dec 39	51
12A7	Half-Wave Rectifier, Power Amplifier Pentode, $P_o = 0.55$	June 41	112
12A8G	Pentagrid Converter, $g_c = 550$	Jan 40	62
12A8GT	Pentagrid Converter, $g_c = 500$	Mar 40	69
12AH7GT	Twin Triode, $\mu = 16$	Apr 41	84
12B6 (M)	Diode, High-mu Triode, $\mu = 100$	Sept 40	66
12B7 (GL)	R-F Pentode, rco, $g_m = 2000$	Dec 39	55
12B7 (ML)	R-F Pentode, rco, $g_m = 2000$	Nov 39	71
12B8GT	Triode, Pentode, $g_m = 1800$	Mar 40	65
12C8 (M)	Double Diode Pentode, $g_m = 1325$	Mar 40	65
12E5GT	Triode, $\mu = 14$	Nov 39	70
12F5GT	High-mu Triode, $\mu = 100$	Mar 40	66
12G7G	Double Diode, High-mu Triode, $\mu = 70$	Feb 40	51
12J5G	Triode, $\mu = 20$	Feb 40	53
12J7G	R-F Pentode, sco, $g_m = 1225$	Apr 40	88
12J7GT	R-F Pentode, sco, $g_m = 1225$	Mar 40	67
12K7G	R-F Pentode, rco, $g_m = 1650$	Jan 40	67
12K7GT	R-F Pentode, rco, $g_m = 1450$	Mar 40	67

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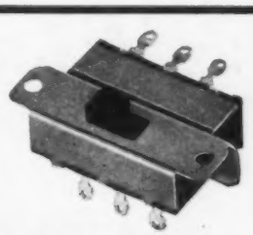

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The Stackpole Model SS-12 Four Pole, Double Throw SLIDE SWITCH is but one of the many models adaptable to all small circuits.

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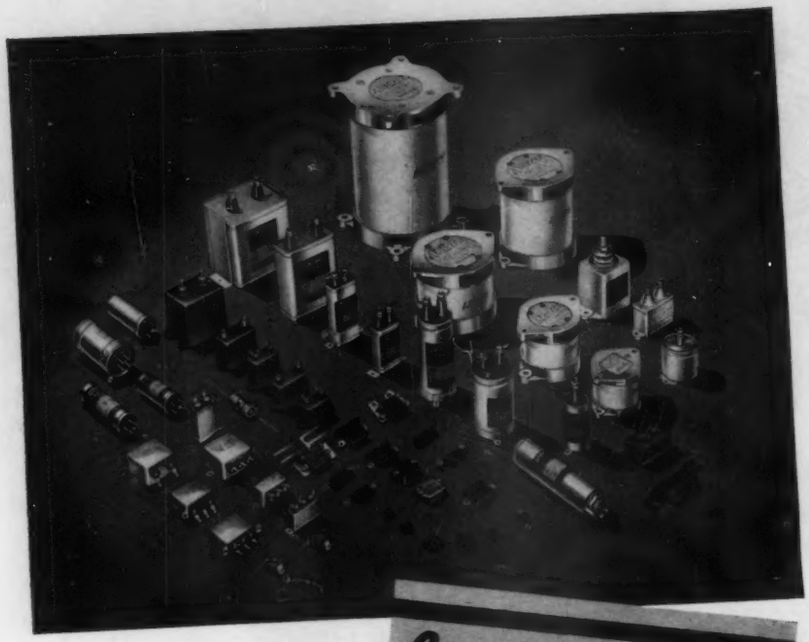

Yesterday, "SPECIAL", today "STANDARD"

Stack-mounting mica capacitors in ceramic cases with cast-aluminum terminal top and bottom, for various transmitting applications such as grid, plate-blocking, coupling, tank, and by-passing functions. In five different sizes. Widest choice of capacities and voltages. A definite "special" now become a standard item at reduced cost.

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Bakelite-case mica capacitors to handle elevated voltages and higher current ratings. Precision-built mica sections, vacuum-impregnated and surrounded by low-loss filler in a one-piece molded bakelite case. Permanent protection against moisture. In standard brown bakelite cases and also in low-loss (yellow) BM262 bakelite. Wide choice of capacities and working voltages. Handy listings indicating maximum current at four popular high frequencies.

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Also mica capacitors in various metal cases and sulphur-filled. Molded-in-bakelite units in many types of cases, mountings, terminals, voltages, capacities.

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Oil-filled capacitors in widest range of can designs, terminals, mountings. High-voltage capacitors in round and rectangular cans, in ratings up to 7500 v. D.C.W.

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Mica padder units adjusted in regular production to as close as 1% of stated capacity. Stabilized by heat treatment. Special impregnating materials produce extremely stable characteristics. Low capacity-temperature variations. Excellent retrace characteristics.

• Until recently these extra-heavy-duty or so-called commercial-grade capacitors in mica, oil-filled, plug-in electrolytics and paper, and other types were "special" or made to order for Government services, communication companies, and builders of quality equipment.

Aerovox, however, has made these types standard items, in regular and therefore economical production, available to you at reduced cost, as a result of meeting the great and growing demand for extra-heavy-duty capacitors. And the giant Aerovox plant, humming day and night, assures you of more than ample production capacity to take care of your capacitor requirements, whether large or small, along with its National Defense commitments. You can count on Aerovox!

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This Aerovox Transmitting Capacitor Catalog, as distinguished from the standard radio catalog, contains engineering data and listings on our commercial-grade line. A registered copy of this loose-leaf catalog is available only to designers, builders and maintenance crews of commercial-grade equipment. Write on business stationery. Meanwhile, send along that capacitor problem.

AEROVOX CORPORATION
New Bedford, Mass.
Sales Offices in All Principal Cities

TYPE	FUNCTION	ISSUE	PAGE
12K8GT	Triode-Hexode Converter, g_c = 350	Nov 39	75
12K8 (M)	Triode-Hexode Converter, g_c = 350	Dec 39	52
12Q7GT	Double Diode, High-mu Triode, μ = 70	Mar 40	68
12SA7G	Pentagrid Converter, g_c = 380	Apr 40	88
12SA7GT	Pentagrid Converter, g_c = 450	Feb 40	51
12SA7 (M)	Pentagrid Converter, g_c = 450	Mar 40	64
12SC7 (M)	Twin Triode, μ = 70	Mar 40	64
12SF5 (M)	High-mu Triode, μ = 100	Nov 39	75
12SF5GT	High-mu Triode, μ = 100	Jan 40	64
12SF7 (M)	Diode, Pentode, rco, g_m = 2050	May 41	69
12SG7	R-F Pentode, semi-rco, g_m = 4000	Apr 41	86
12SJ7GT	R-F Pentode, sco, g_m = 1650	Jan 40	60
12SJ7 (M)	R-F Pentode, sco, g_m = 1650	Mar 40	64
12SK7GT	R-F Pentode, rco, g_m = 1650	Jan 40	64
12SK7 (M)	R-F Pentode, rco, g_m = 2000	Mar 40	64
12SN7GT	Double Triode, μ = 20	June 41	110
12SQ7GT	Double Diode, High = mu Triode, μ = 100	Jan 40	60
12SQ7 (M)	Double Diode, High-mu Triode, μ = 100	Mar 40	64
12SR7 (M)	Double Diode, Triode, μ = 16	Dec 39	51
12Z3	Half-Wave Rectifier, I_{dc} = 55	Apr 41	86
14A4 (GL)	Triode, μ = 20	Dec 40	63
14A5 (GL)	Beam Power Amplifier, P_o = 2.5	Dec 40	64
14B6 (GL)	Duo-Diode, High-mu Triode, μ = 100	May 40	58
14B8 (GL)	Pentagrid Converter, g_c = 550	Dec 40	64
14C5 (GL)	Beam Power Amplifier, P_o = 5.5	Dec 40	63
14C7 (GL)	R-F Pentode, sco, g_m = 1575	Dec 40	64
14E6 (GL)	Duo-diode, Medium-mu Triode, μ = 16	Jan 41	65
14E7 (GL)	Duodide, Pentode, g_m = 1300	June 41	111
14H7 (GL)	R-F Pentode, semi-rco, g_m = 3800	Oct 40	65
14J7fs(GL)	Triode-Hexode Converter, rco, g_c = 310	Nov 39	71
14Q7 (GL)	Heptode Converter, g_c = 450	May 40	58
14R7 (GL)	Duodiode, Pentode, rco, g_m = 3200	May 41	69
15	R-F Pentode, g_m = 750	June 41	112
18	Power Amplifier Pentode, P_o = 3.2	Apr 41	87
20	Power Amplifier Triode, P_o = 0.11	Feb 41	70
20G8 fs (GM)	Triode-Heptode Converter, g_c = 270	Nov 39	75
24A	Screen Grid R-F Amplifier, g_m = 1050	June 41	113
25A6 G	Power Amplifier Pentode, P_o = 2	Apr 41	86
25A6GT	PA Pentode, P_o = 2.2	June 40	76
25A7	PA Pentode, P_o = 0.77	Sept 40	69
25A7GT	Half-Wave Rectifier, PA Pentode, P_o = 0.77	June 40	78
25AC5G	PA Tricde, P_o = 3.3	Apr 40	92
25AC5GT	Power Amplifier Triode, P_o = 2.0	Nov 39	72
25B5	Dynamic-Coupled PA, P_o = 3.8	Sept 40	69
25B6G	PA Pentode, P_o = 7.1	Sept 40	68
25B8GT	Triode, Pentode, g_m = 2000	Feb 40	54
25C6G	Beam Power Amplifier, P_o = 6.0	Jan 40	66
25D8GT	Diode, Triode, Pentode, rco, g_m = 1900	Feb 40	56
25L6	Beam Power Amplifier, P_o = 2.2	Aug 40	70
25L6G	Beam Power Amplifier, P_o = 2.2	Sept 40	69
25L6GT	Beam Power Amplifier, P_o = 2.2	June 40	78
25N6G	Dynamic Coupled, PA, P_o = 3.8	Sept 40	70
25X6GT	Rectifier, Doubler, I_{dc} = 60	Feb 40	56
25Y4GT	Half-Wave Rectifier, I_{ds} = 75	Dec 39	54
25Y5	Full Wave Rectifier Doubler, I_{dc} = 75	Nov 40	68
25Z4	Half-Wave Rectifier, I_{dc} = 125	Apr 40	96
25Z4GT	Half-Wave Rectifier, I_{ds} = 125	Dec 39	54

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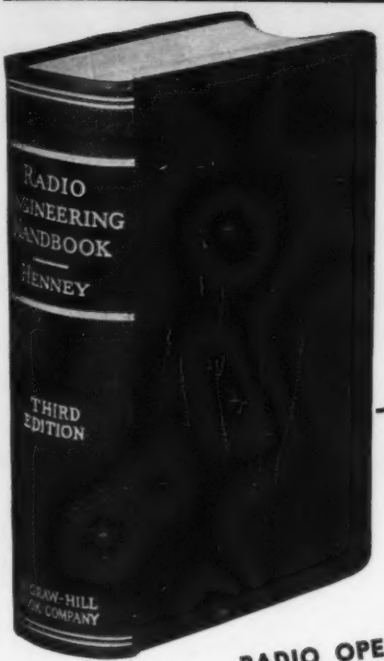

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UNDERSTANDING RADIO

By Watson, Welch and Eby. An A-B-C book on radio with a sound technical background. Covers the radio field from the very beginning—no previous knowledge of radio or electricity is necessary—and gives you a complete basic understanding of radio receivers and transmitters including the ability to construct and test the various types, and a knowledge of the principles that make each part work and how they work together. Has close likeness to personal instruction, combining instructions, construction, experiments, and explanation of results at every step. 601 pp., 406 illus., $2.80.

PRINCIPLES OF TELEVISION ENGINEERING

By Donald Fink. This new fact-packed book readies you for the opportunities ahead in television. It covers the whole field of design, operation and maintenance, enables you to make the transition from familiarity with radio to familiarity with television. The book conveniently gives all basic principles on which television rests, and illustrates the application of these principles in standards of transmission and in practical equipment now in use. Covers all functions of television equipment and provides data on which design and operation of equipment depends. Traces entire process from studio camera to receiver screen. 541 pp., 313 illus., $5.00.

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Type	Function	Issue	Page
25Z5	Full-Wave Rectifier Doubler, I_{dc} = 75	Feb 41	68
25Z6 (G)	Full-Wave Rectifier Doubler, I_{dc} = 75	Feb 41	70
25Z6GT	Full-Wave Rectifier, Doubler, I_{dc} = 75	June 40	78
27	Detector Amplifier Triode, μ = 9	June 41	113
32L7GT	Rectifier, Beam PA, P_o = 1.0	Mar 40	69
35A5GL	Beam Power Amplifier, P_o = 1.4	Apr 40	95
35A5LT	Beam Power Amplifier, P_o = 1.5	Nov 39	74
35L6G	Beam Power Amplifier, P_o = 1.5	Jan 40	67
35L6GT	Beam Power Amplifier, P_o = 1.5	Apr 40	94
35Y4 (GL)	Half-Wave Rectifier, I_{dc} = 100	Jan 41	65
35Z3 (GL)	Half-Wave Rectifier, I_{dc} = 100	Apr 41	86
35Z3LT	Half-Wave Rectifier, I_{dc} = 100	Nov 39	74
35Z4GT	Half-Wave Rectifier, I_{dc} = 100	Apr 40	94
35Z5G	Half-Wave Rectifier, I_{dc} = 100	Jan 40	62
35Z5GT	Half-Wave Rectifier, I_{dc} = 100	Mar 40	66
35Z6G	Rectifier Doubler, I_{dc} = 110	May 40	61
35/51	Super-Control, Screen-Grid, R-F Amplifier, g_m = 1050	June 41	114
36	Screen-Grid R-F Amplifier, g_m = 1080	June 41	115
37	Amplifier Triode, μ = 9.2	June 41	115
38	Power Amplifier Pentode, P_o = 2.5	June 41	115
39/44	Super-Control, R-F Pentode, g_m = 1050	June 41	115
40Z5/45Z5GT	Identical with 45Z5GT	Feb 40	50
41	Power Amplifier Pentode, P_o = 3.4	Feb 41	72
42	Power Amplifier Pentode, P_o = 3.2	Apr 41	86
43	PA Pentode, P_o = 2.2	Oct 40	66
45Z3 (GB)	Half-Wave Rectifier, I_{dc} = 65	June 41	111
45Z5GT	Half-Wave Rectifier, I_{dc} = 100	Feb 40	53
48	Power Amplifier Tetrode, P_o = 3.0	June 41	116
49	Dual-Grid Power Amplifier, P_o = 0.17	Apr 41	88
50	Power Amplifier Triode, P_o = 4.6	Feb 41	72
50A5 (GL)	Beam Power Amplifier, P_o = 4.7	Jan 41	65
50C6G	Beam Power Amplifier, P_o = 6	Dec 39	51
50L6GT	Beam Power Amplifier, P_o = 1.75	Feb 40	56
50Y6G	Rectifier-Doubler, I_{dc} = 75	Apr 40	90

• • •

REFUGEES SEND EASTER GREETINGS

Easter greetings are exchanged by young British refugees and their parents in London as the former rode down Fifth Ave. during the recent Easter parade in New York

Type	Function	Issue	Page
50Y6GT	Rectifier Doubler, I_{dc} = 75	Dec 39	56
50Z6G	Full-Wave Rectifier, I_{dc} = 250	June 40	74
50Z7G	Rectifier Doubler, I_{dc} = 65	Dec 39	56
53	Twin Triode Power Amplifier, P_o = 10	Apr 41	88
55	Duodiode, Triode, μ = 8.3	June 41	116
70A7GT	Rectifier, Beam PA, P_o = 1.5	Dec 39	57
70L7GT	Rectifier, Beam PA, P_o = 1.8	Feb 40	56
75	Duodiode, High-mu, Triode, μ = 100	Feb 41	72
76	Detector Amplifier Triode, μ = 13.8	June 41	117
77	Triple-Grid Detector Amplifier, sec. g_m = 1250	Apr 41	86
78	Triple-Grid Super-Control Amplifier, rec. g_m = 1450	Apr 41	86
79	Class B Amplifier, P_o = 8.0	June 41	117
80	Full-Wave Rectifier, I_{dc} = 125	May 41	76
81	Half-Wave Rectifier I_{dc} = 85	Mar 41	77
82	Full-Wave Mercury Vapor Rectifier, I_{dc} = 115	Feb 41	72
83	Full-Wave Mercury Vapor Rectifier, I_{dc} = 225	Mar 41	81
83V	Full-Wave Rectifier, I_{dc} = 175	Nov 40	72
84/6Z4	Full-Wave Rectifier, I_{dc} = 60	Oct 40	66
85	Duodiode, triode, μ = 8.3	June 41	118
89	Power Amplifier Pentode, P_o = 3.4	June 41	118
V99	Detector Amplifier Triode, μ = 6.6	Mar 41	79
X99	Detector Amplifier Triode, μ = 6.6	Mar 41	79
117L7GT	Rectifier, Beam PA, P_o = 0.55	Nov 39	74
117L7/ 117M7GT	Rectifier, Beam Tetrode, P_o = 0.85	Mar 41	77
117M7GT	Rectifier, Beam Power Amplifier, P_o = 1.3	May 40	61
117N7GT	Rectifier, Beam Power Amplifier, P_o = 1.2	July 40	57
117P7 (GT)	Rectifier, Beam Tetrode, P_o = 0.85	Mar 41	77
117Z4GT	Half-Wave Rectifier I_{dc} = 90	June 41	110
117Z6G	Full-Wave Rectifier, I_{dc} = 60	Jan 40	62
117Z6GT	Full-Wave Rectifier, Doubler, I_{dc} = 60	May 40	56
1231	Triple-Grid Amplifier, g_m = 5500	June 41	118
1851	Triple-Grid Amplifier, g_m = 9000	June 41	118

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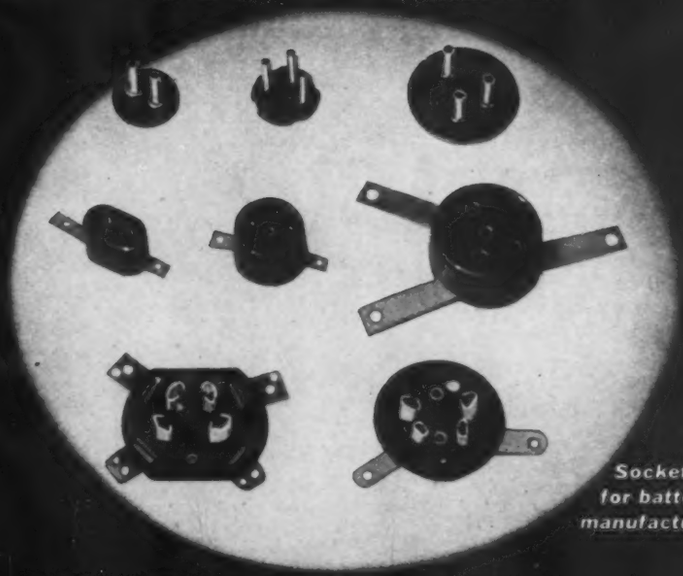
EARS EAST

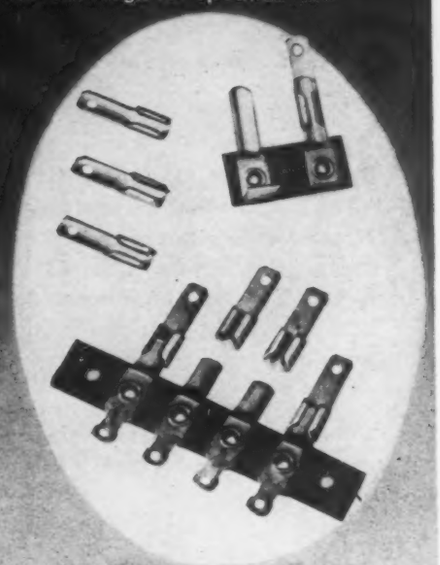
Members of the Canadian East Coast anti-aircraft battery are shown at one of the listening posts where they are picking up sounds from the sky as a warning of approaching aircraft

FRANKLIN



Sockets for battery manufacturers

As the leading supplier of laminated sockets and parts to radio and electrical equipment manufacturers, Franklin has enlarged its line to include MOLDED SOCKETS for aviation, battery, electrical, instrument, radio and allied apparatus. Plugs to match. Plugs for speaker and cable manufacturers.



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Astatic N-Series Microphones will be displayed at the Radio Parts National Trade Show, and are included in Astatic's new 1941 Catalog, now available.

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TYPE	FUNCTION	ISSUE	PAGE
Picture Tubes			
3AP1	Electrostatic, E = 1500	Jan 40	67
3AP4	Electrostatic, E = 1500	Jan 40	67
5AP1	Electrostatic, E = 1500	Feb 40	55
5AP4	Electrostatic, E = 1500	Feb 40	55
5BP1	Electrostatic, E = 2000	Jan 40	67
5BP4	Electrostatic, E = 2000	Jan 40	66
7AP4	Magnetic, E = 3500	Dec 39	52
9AP4	Magnetic, E = 7000	Jan 40	66
9CP4	Magnetic, E = 7000	Oct 40	65
12AP4	Magnetic, E = 7000	Jan 40	66
12CP4	Magnetic, E = 7000	Oct 40	65
Cold Cathode Types (Ionically Heated Cathodes)			
0A4G	Cold Cathode, Glow Discharge Tube, I_{dc} = 25	June 40	74
0Z3	Full-Wave Gas-Filled Rectifier, I_{dc} = 75	Oct 40	67
0Z4 |	Full-Wave Gas-Filled Rectifier, I_{dc} = 75	Oct 40	67
Voltage Regulators			
VR-90	Voltage Regulator	June 41	117
VR-150	Voltage Regulator	June 41	117
874	Voltage Regulator	June 41	117

Explanation of suffixes

G	Glass envelope and octal base
(GB)	Integral T-5½ glass envelope and base
(GL)	Integral T-9 glass envelope and loktal base
(GM)	Metal coated glass envelope with octal base
GT	Short T-9 glass envelope and octal base
LM	MT-8 metal envelope and octalox base
LT	T-9 glass envelope and octalox base
M	Metal envelope and octal base
FS	Foreign service

• • •

RADIO SETS FOR BRITISH TROOPS

British factories are engaged in the manufacture of battery operated radio receivers to be distributed to the troops. Here is a group of receivers waiting to be placed in cabinets after final test in a London factory

Tube Registry

Tube Types Registered by R.M.A. Data Bureau During April, 1941

Type 1SA6GT

PENTODE voltage amplifier; sco; filament type; T-9 glass envelope; seated height 2¾ inches (max); 8-pin octal base.

RATINGS
E_f = 1.4 v
I_f = 0.05 amp
E_b = 90 v (max)
I_{c1} = 67.5 v (max)

TYPICAL OPERATION
E_b = 90 v
E_{c1} = 67.5 v
E_c = 0 v
I_b = 2.45 ma
I_{c1} = 0.68 ma
g_m = 970 μmhos
r_p = 0.8 megohm
C_{in} = 5.2 μμf
C_{out} = 8.6 μμf
C_{gp} = 0.01 μμf (max)
Basing 6BD–1–7

Type 1SB6GT

DIODE-PENTODE voltage amplifier; filament type; T-9 glass envelope; seated height 2¾ inches (max); 7-pin octal base.

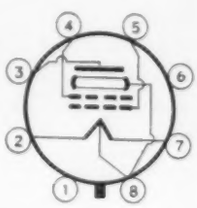
RATINGS
E_f = 1.4 v
I_f = 0.05 amp
E_b = 90 v (max)
E_{c2} = 67.5 v (max)

TYPICAL OPERATION
E_b = 90 v
E_{c2} = 67.5 v
E_c = 0 v
I_b = 1.45 ma
I_{c2} = 0.38 ma
g_m = 665 μmhos
r_p = 0.7 megohm
C_{in} = 3.2 μμf
C_{out} = 3.0 μμf
C_{gp} = 0.25 μμf (max)
C pentode plate —diode plate) = 0.5 μμf
Basing 6BE–0–0

Type 3B5GT

BEAM power amplifier; filament type; T-9 glass envelope; seated height 2¾ inches (max); 7-pin octal base.

RATINGS
E_f = 1.4 or 2.8 v
I_f = 0.10 or 0.05 amp
E_b = 67.5 v (max)
E_{c2} = 67.5 v (max)



TYPICAL OPERATION
(With series filament)
E_f = 2.8 v
I_f = 0.05 amp
E_b = 67.5 v
E_{c2} = 67.5 v
E_c = −7 v
I_b = 6.7 ma
I_{c2} = 0.5 ma
g_m = 1500 μmhos
r_p = 0.1 megohm
R_l = 5000 ohms
P_o = 0.18 watts (10%)
Basing 7AP–0–0

3 REASONS

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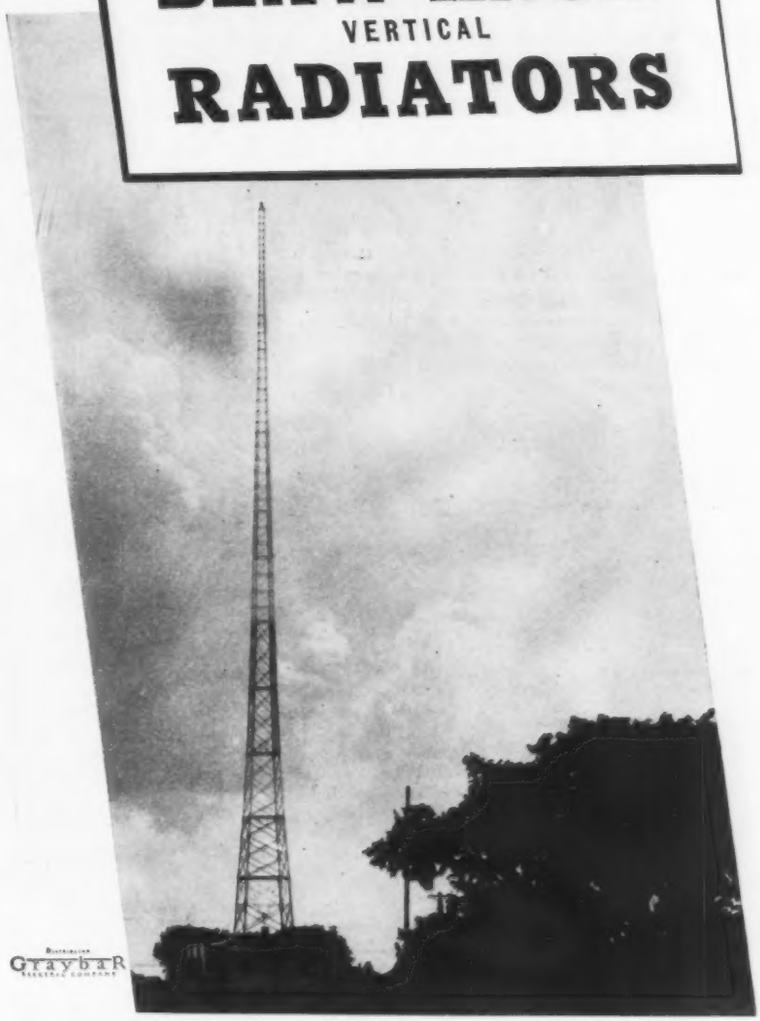

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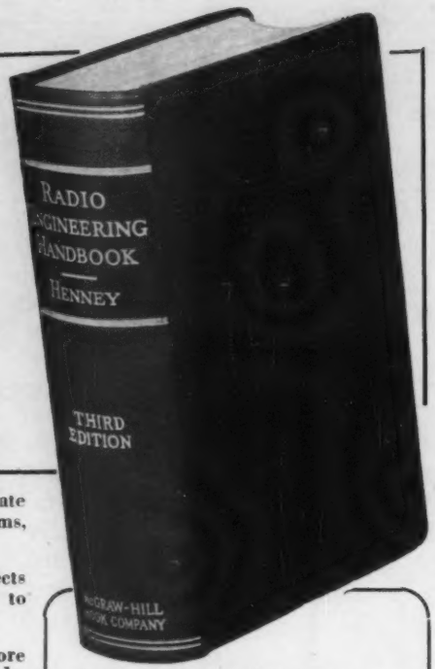

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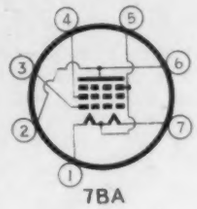
Type 3Q4 (GB)

MINIATURE pentode power amplifier; T-5½ integral glass envelope-base; seated height 1¾ inches (max); 7-pin button base.

RATINGS
E_f = 2.8 or 1.4 v
I_f = 0.05 or 0.1 amp
E_b = 90 v (max)
E_{c2} = 90 v (max)

TYPICAL OPERATION
(With Series Filament)
E_f = 2.8 v
I_f = 0.05 amp
E_b = E_{c2} = 90 v
E_c = − 4.5 v
I_b = 7.7 ma
I_{c2} = 1.7 ma
r_p = 0.12 megohm (approx)
g_m = 2000 μmhos
R_l = 10,000 ohms
P_o = 0.24 watt (7%)
Basing 7BA–0–0



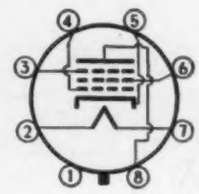
7BA

Type 6SS7 (M)

PENTODE voltage amplifier; rco; heater type MT-8 metal envelope; seated height 2$\frac{1}{16}$ inches (max); 8-pin octal base.

RATINGS
E_f = 6.3 v
I_f = 0.15 amp
E_b = 300 v (max)
E_{c2} = 100 v (max)
E_c = 0 v (min)

TYPICAL OPERATION
E_b = 250 v
E_{c2} = 100 v
E_c = − 3 v
I_b = 9 ma
I_{c2} = 2 ma
g_m = 1850 μmhos
r_p = 1.0 megohm
E_{c1} = − 35 v
g_m = 10 μmhos
C_{in} = 5.5 μμf
C_{out} = 7.0 μμf
C_{gp} = 0.004 μμf (max)
Basing 8N–1–1

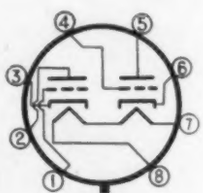


Type 12SN7GT

DOUBLE triode, heater type, T-9 glass envelope; seated height 2$\frac{3}{4}$ inches (max); 8-pin octal base.

RATINGS
E_f = 12.6 v
I_f = 0.3 amp
E_b = 300 v (max)
E_c = 0 v (min)

TYPICAL OPERATION
(Each triode unit)
E_b = 250 v
E_c = − 8 v
I_b = 9 ma
μ = 20
g_m = 2600 μmhos
r_p = 7700 ohms
Basing 8BD–0–0



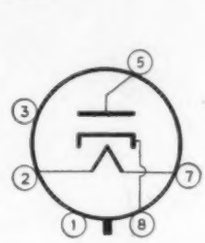
8BD

Type 117Z4GT

HALF-WAVE rectifier; heater type; T-9 glass envelope; seated height 2$\frac{3}{4}$ inches (max); 6-pin octal base.

RATINGS
E_f = 117 v
I_f = 0.040 amp
E_p = 117 v (max)
E_{in} = 350 v (max) pk
I_p (peak) = 540 ma
E_{drop} @ 180 ma = 22.5 v
E_{bb} = 175 v

TYPICAL OPERATION
E_p = 117 v
I_b = 90 ma
Minimum total plate supply impedance = 30 ohms
Basing 5AA–0–0



Type 14E7 (GL)

DOUBLE diode, pentode, rco; heater type T-9 integral glass envelope-base; seated height 2¼ inches (max); 8-pin lock-in base.

RATINGS
E_f = 14.0 v
I_f = 0.16 amp
E_b = 250 v (max)
E_{c2} = 100 v (max)
E_c = 0 volts (min)

TYPICAL OPERATION
E_f = 12.6 v
I_f = 0.15 amp
E_b = 250 v
E_{c2} = 100 v
E_c = − 3 v
I_b = 7.5 ma
I_{c2} = 1.6 ma
g_m = 1300 μmhos
r_p = 0.7 megohm
E_c = − 42.5 v
g_m = 2 μmhos
C_{in} = 4.6 μμf
C_{out} = 5.3 μμf
C_{gp} = 0.005 μμf (max)
C (diode 1-grid 1) = 0.005 μμf (max)
C (diode 2-grid 1) = 0.002 μμf (max)
Basing 8AE–L–7

Type 45Z3 (GB)

HALF-WAVE rectifier; heater type; T-5½ integral glass envelope-base; seated height 1⅞ inch (max); 7-pin button base.

RATINGS
E_f = 45 v
I_f = 0.075 amp
E_{inv} = 350 v (max) peak
I_{peak} = 390 ma (max)
E_{kk} = 175 v (max)

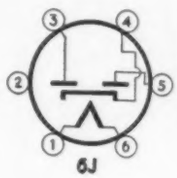
CONDENSER INPUT TO FILTER
E_{ac}(rms) = 117 v (max)
I_k = 65 ma (max)
Total effective plate supply impedance = 15 ohms (min)
Basing 5AM–0–0

Tube Types Previously Announced

Type 6Y5

FULL-WAVE high-vacuum rectifier, heater type, ST-12 glass envelope, seated height 3 $^{5}/_{16}$ inches (max), 6-pin base.

E_h = 6.3 v
I_h = 0.8 amp
CONDENSER INPUT TO FILTER
E_{ac} (per plate) = 350 v
I_{dc} = 50 ma
Basing 6J–2–0



Type 6Z5

FULL-WAVE, high-vacuum rectifier, heater type, ST-12 glass envelope, 3 $^{5}/_{16}$ inches (max), 6-pin base.

E_h = 6.3 or 12.6 v
I_h = 0.8 or 0.4 amp
E_{ac} = 230 v
I_{dc} = 60 ma
Basing 6K—0—0

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The most exacting of all types of communications in aviation is ship to airport.

Thordarson engineers are pioneers in aviation communications problems. With the aid of this constant research Thordarson has developed the finest audio transformers skilled craftsmen can produce. The dependability of Thordarson transformers is recognized throughout the Aviation industry where human life depends upon accurate performance of equipment.

Thordarson builds a transformer for every electronic requirement. Take advantage of 46 years of experience—submit your transformer problems to Thordarson engineers.

THORDARSON

ELEC. MFG. CO.

500 W. Huron St. Chicago, Ill.

TRANSFORMER SPECIALISTS SINCE 1895

Aviation illustrations courtesy Braniff Airways Inc. Arrow points to "Incher" series audio transformer used in mobile aircraft series contrasted with modulation transformers used in ground series.

Chief Engineer gives

LOW-DOWN on PICK-UP!

"Easy to scalp pick-up problems when you use Western Electric 639B mike," says the Chief. "Take choice of six patterns at turn of switch and watch feedback and reverberation bite dust! No set-up too tough for this papoose. For whole story, send runner quick to Graybar Electric Co., Graybar Building, New York, N. Y."

Western Electric

XCELITE

★ ★

QUALITY TOOLS

"Preferred by the Experts"

SCREWDRIVERS

• XceLite is the original shock-proof screwdriver. The transparent handle is extremely tough and durable, with high dielectric strength. Blade of real alloy steel. The ideal tool for all kinds of electrical and radio work. Over 50 sizes and styles, square and round blades, fully insulated blades if desired. Details and prices on request.

NUT DRIVERS

• XceLite nut drivers are just the tools for work requiring sturdy, accurate extra-deep sockets—deep enough to handle two nuts. Excellent for work on panel equipment. Genuine shock-proof XceLite handle. Available in 6" and 9" lengths, 9 sizes from 3/16" to 1/2" nut size; also insulated shafts, if desired, also Stubby Nut Drivers and Hollow Shaft Nut Drivers.

SPECIAL TOOLS *for Industry*

We are equipped to manufacture special screwdrivers of highest quality, designed to meet the individual requirements of the users. Many of the largest industrial plants in the country are now availing themselves of this service. Full details on request.

PARK METALWARE CO., INC.

ORCHARD PARK NEW YORK

Type 12A7

HALF-WAVE rectifier, pentode power amplifier, heater type, ST-12 glass envelope, seated height 3 3/32 inches (max), 7-pin base.

E_f = 12.6 v
I_f = 0.3 amp
PENTODE SECTION
E_b = 135 v
E_{c2} = 135 v
E_c = − 13.5 v
I_b = 9.0 ma
I_{c2} = 2.5 ma
R_i = 13500 ohms
P_o = 0.55 watt
RECTIFIER SECTION
E_{ac} = 125 v (max)
I_{dc} = 30 ma (max)
$E_{d,rep}$ (I_{dc} = 60 ma) = 15 v
Basing 7K–0–0

Type 10

POWER amplifier triode, filament type, ST-16 glass envelope, seated height 4 3/4 inches (max), 4-pin base.

E_f = 7.5 v
I_f = 1.25 amp
E_b = 425 v (max)
E_c = − 40 v
I_b = 18 ma
R_i = 10200 ohms
P_o = 1.6 watts
Basing 4D–0–0

Type 12A

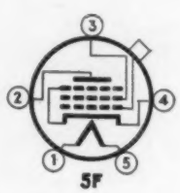
DETECTOR amplifier, filament type, ST-14 glass envelope, seated height 4 7/16 inches (max), 4-pin base.

E_f = 5.0 v
I_f = 0.25 amp
E_b = 180 v
E_c = − 13.5 v
I_b = 7.7 ma
μ = 8.5
g_m = 1800 μmhos
R_i = 10650 ohms
P_o = 0.285 watt
Basing 4D–0–0

Type 15

R-F PENTODE, heater type, ST-12 glass envelope, seated height 3 9/16 inches (max), 5-pin base.

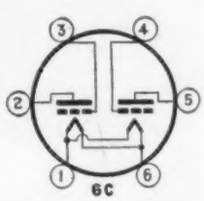
E_f = 2.0
I_f = 0.22 amp
E_b = 135 v
E_{c2} = 67.5 v
E_c = − 1.5 v
I_b = 1.85 ma
I_{c2} = 0.3 ma
g_m = 750 μmhos
r_p = 0.8 megohm
Basing 5F–0–4



Type 19

CLASS B power amplifier, filament type, ST-12 glass envelope, seated height 3 9/16 inches, 6-pin base.

E_f = 2.0 v
I_f = 0.26 amp
E_b = 135 v
E_c = − 6 v
I_b (zero signal) = 0.2 ma
I_b (signal 50 v grid to grid) = 22.0 ma
R_i = 10,000 ohms
P_o = 1.6 watt
Basing 6C–0–0



SHALLCROSS
ELECTRICAL MEASURING EQUIPMENT

•

Precision-Built for Perfect Performance

Aryton Universal Shunts
Ratio Boxes
Standard Resistances
(1 ohm to 10 million ohms)
Secondary Standards
Multi-Resistance Standards
Potentiometers—Decade Type
Decade Resistance Standards
(Heavy Duty)
Megohm Decade Resistance Standards
Megohmmeters
Percent Limit Bridges
Wheatstone Bridges
Kelvin-Wheatstone Bridges
Bonding Testers
Milliohmmeters
Decade Resistance Boxes
High Voltage Measuring Apparatus
Kilovoltmeters
Telephone Transmission Testing Equipment
Fault Location Bridges
Ground Resistometers

•

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BUILT TO YOUR SPECIFICATIONS

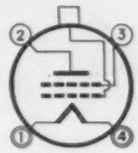
Send for a copy of our new
GENERAL PRICE LIST No. 10-KQ
Just off the press!

SHALLCROSS MFG. CO.
Instruments – Resistors – Switches
COLLINGDALE, PA.

Type 22

SCREEN-GRID r-f amplifier, filament type, ST-14 glass envelope, seated height $4\frac{13}{32}$ inches (max), 4-pin base.

E_f = 3.3 v
I_f = 0.132 amp
E_b = 135 v
E_{c2} = 67.5 v
E_c = − 1.5 v
I_b = 3.7 ma
I_{c2} = 1.3 ma
g_m = 500 μmhos
r_p = 0.25 megohm
Basing 4K–0–0



4K

Type 24A

SCREEN-GRID r-f amplifier, heater type, ST-14 glass envelope, seated height $4\frac{13}{32}$ inches (max), 5-pin base.

E_h = 2.5 v
I_h = 1.75 amp
E_b = 250 v
E_{c2} = 90 v
E_c = − 3 v
I_b = 4 ma
I_{c2} = 1.7 ma
g_m = 1050 μmhos
r_p = 0.6 megohm
Basing 5E–0–3

5E

Type 26

TRIODE amplifier, filament type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches, 4-pin base.

E_f = 1.5 v
I_f = 1.05 amp
E_b = 180 v
E_c = − 14.5 v
I_b = 6.2 ma
μ = 8.3
g_m = 1150 μmhos
Basing 4D–0–0

4D

Type 27

DETECTOR amplifier, heater type, ST-12 glass envelope, seated height $3\frac{9}{16}$ inches, 5-pin base.

E_h = 2.5 v
I_h = 1.75 amp
E_b = 250 v
E_c = − 21 v
I_b = 5.2 ma
μ = 9
g_m = 975 μmhos
Basing 5A–0–0

5A

Type 30

TRIODE detector amplifier, filament type ST-12 glass envelope, seated height $3\frac{9}{16}$ inches (max), 4-pin base.

E_f = 2.0 v
I_f = 0.06 amp
E_b = 180 v
E_c = − 13.5 v
I_b = 3.1 ma
μ = 9.3
g_m = 900 μmhos
Basing 4D–0–0

4D

Precisely Calibrated
SHALLCROSS "AKRA-OHM" RESISTORS

Specially designed for manufacturers and users of electrical measuring instruments, electrical and radio testing equipment and other high-grade electrical apparatus.

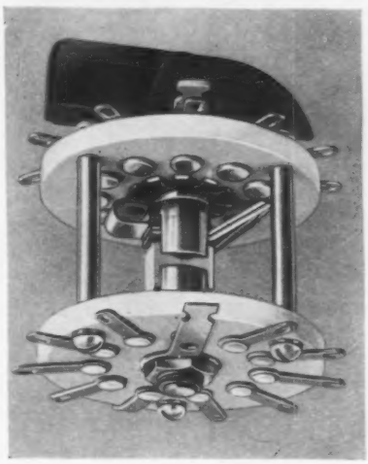
Resistors bearing the SHALLCROSS name are available in a wide variety of types and forms, and special types can be furnished.

Moisture-proof — THEY HOLD THEIR CALIBRATIONS.

Write for Bulletin #122-KQ

•

FOR *Permanent* LOW CONTACT RESISTANCE, *use*
SHALLCROSS SELECTOR SWITCHES

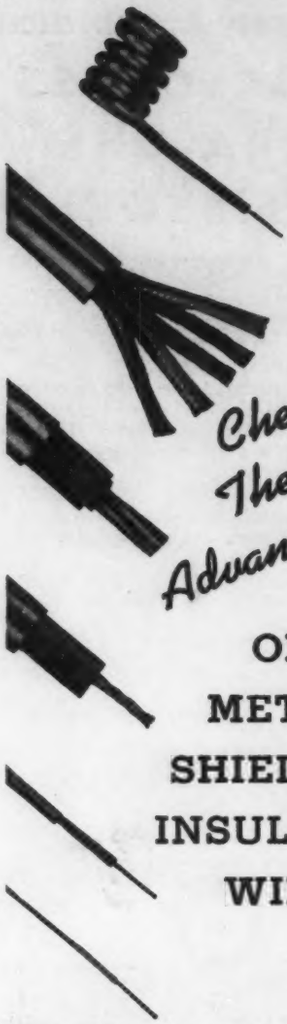


The switch plate is made with a very superior material known as a "steatite" having "fine" silver contacts and contact arms. The available contact resistance is .00075 ohms or less.

Cost slightly more but worth much more because they last longer and are more accurate.

Write for Bulletin #500-KQ

SHALLCROSS MFG. CO.
Instruments – Resistors – Switches
COLLINGDALE, PA.



Check These Advantages

OF METAL SHIELDED INSULATED WIRE

★ **Complete elimination of moisture from condensation or outside sources**

★ **Light in weight yet gives absolute electrical plus mechanical protection**

★ **Ease of installation and repair —No special tools required for cutting to length, bending or fitting**

★ **Positive protection to wire or cable against corrosion and abrasion**

★ **Prevents Radio interference**

★ **Furnished in exact, multiple or random lengths with *Seamless* Aluminum, Copper or Brass Tubing drawn over any type of wire or wires.**

SEND FOR FREE SAMPLES

We also specialize in accurately drawn Seamless ALUMINUM Alloy, COPPER and BRASS Tubing in a range of sizes from 3/8" O.D. on down to 0.0125" O.D. with any wall thickness.

PRECISION TUBE COMPANY

3826 Terrace Street
Philadelphia, Pa.

Type 31

TRIODE power amplifier, filament type, ST-12 glass envelope, seated height $3\frac{5}{16}$ inches (max), 4-pin base.

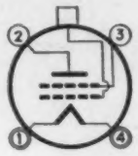
E_f = 2.0 v
I_f = 0.13 amp
E_b = 180 v
E_c = − 30 v
I_b = 12.3 ma
R_l = 5700 ohms
P_o = 0.375 watt
Basing 4D–0–0

4D

Type 32

SCREEN-GRID r-f amplifier, filament type, ST-14 glass envelope, seated height $4\frac{13}{32}$ inches, 4-pin base.

E_f = 2.0 v
I_f = 0.06 amp
E_b = 180 v
E_{c2} = 67.5 v
E_c = — 3.0 v
I_b = 1.7 ma
I_{c2} = 0.4 ma
g_m = 650 μmhos
r_p = 1.2 megohm
Basing 4K–0–3



4K

Type 57

TRIPLE-GRID detector amplifier, sco, heater type ST-12 glass envelope, seated height $4\frac{5}{16}$ inches (max), 6-pin base.

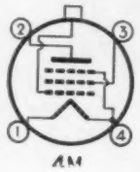
E_h = 2.5 v
I_h = 1.0 amp
E_b = 250 v
E_{c2} = 100 v
E_c = − 3 v
I_b = 2 ma
I_{c2} = 0.5 ma
g_m = 1225 μmhos
r_p = 1.5 megohm
Basing 6F–0–5

6F

Type 34

SUPER-CONTROL r-f amplifier pentode, rco, filament type, ST-14 glass envelope, seated height $4\frac{13}{32}$ inches, 4-pin base.

E_f = 2.0 v
I_f = 0.06 amp
E_b = 180 v
E_{c2} = 67.5 v
E_c = − 3.0 v
I_b = 2.8 ma
I_{c2} = 1.0 am
g_m = 620 μmhos
r_p = 1.0 megohm
Basing 4M–0–4



4M

Type 35/51

SUPER-CONTROL, screen-grid r-f amplifier, heater type, ST-14 glass envelope, seated height $4\frac{13}{32}$ inches (max), 5-pin base.

E_f = 2.5 v
I_f = 1.75 amp
E_b = 250 v
E_{c2} = 90 v
E_c = − 3.0 v
I_b = 6.5 ma
I_{c2} = 2.5 ma
g_m = 1050 μmhos
r_p = 0.4 megohm
Basing 5E–0–3

5E

A Dependable

MINIATURE FREQUENCY METER

FOR POWER FREQUENCIES—BETWEEN 15 AND 500 CYCLES PER SECOND

Frahm Frequency Meters indicate by the resonant vibration of accurately tuned steel reeds, which hold their original calibration for a very long time. Simple. Rugged. Unaffected by wave form or by ordinary voltage and temperature changes. Wide range portable and switchboard types also available.

Write for Bulletin 1555-E

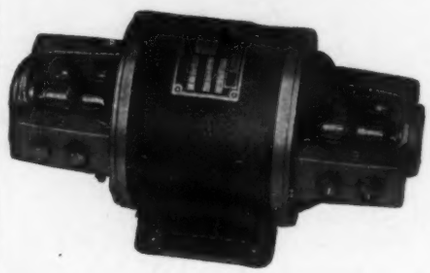
JAMES G. BIDDLE CO.

ELECTRICAL INSTRUMENTS

1211-13 ARCH STREET PHILADELPHIA, PA.

New Carter AIRCRAFT TYPE GENEMOTORS

● **TRIPLE OUTPUT!!**—Think what this means —3 separate outputs from a single Dynamotor! The new Carter Triple Output Dynamotor shown below, is winning wide acclaim in the Aircraft Industry because of its high efficiency, small size, and extra light weight.



● Write today for descriptive literature on Carter Dynamotors—D.C. to A.C. Converters—Double and Triple Output Dynamotors—Magmotors—Special Motors—High Frequency Converters—and Permanent Magnet Dynamotors.

Carter Motor Co.
CHICAGO ILLINOIS

1606 Milwaukee Ave. Cable: Genemotor

Carter, a well known name in Radio since 1922

Type 36

SCREEN-GRID r-f amplifier, heater type, ST-12 glass envelope, seated height $3\frac{29}{32}$ inches (max), 5-pin base.

E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_{c2} = 90 v
E_c = − 3.0 v
I_b = 3.2 ma
I_{c2} = 1.7 ma (max)
g_m = 1080 μmhos
r_p = 0.55 megohm
Basing 5E–0–3

5E

Type 37

AMPLIFIER triode, heater type, ST-12 glass envelope, seated height $3\frac{9}{16}$ inches, 5-pin base.

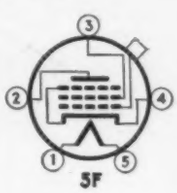
E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_c = − 18 v
I_b = 7.5 ma
μ = 9.2
g_m = 1100 μmhos
Basing 5A–0–0

5A

Type 38

POWER amplifier pentode, heater type, ST-12 glass envelope, seated height $3\frac{29}{32}$ inches (max), 5-pin base.

E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_{c2} = 250 v
E_c = − 25 v
I_b = 22.0 ma
I_{c2} = 3.8 ma
R_l = 10,000 ohms
P_o = 2.5 watts
Basing 5F–0–0



5F

Type 39/44

SUPER-CONTROL r-f pentode, rco, heater type, ST-12 glass envelope, seated height $3\frac{29}{32}$ inches (max), 5-pin base.

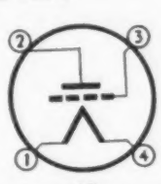
E_h = 6.3 v
I_h = 0.3 v
E_b = 250 v
E_{c2} = 90 v
E_c = − 3 v
I_b = 5.8 ma
I_{c2} = 1.4 ma
g_m = 1050 μmhos
r_p = 1.0 megohm
Basing 5F–0–4

5F

Type 40

VOLTAGE amplifier triode, filament type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches (max), 4-pin base.

E_f = 5.0 v
I_f = 0.25 amp
E_b = 180 v
E_c = − 3.0 v
I_b = 0.2 ma
μ = 30
g_m = 200 μmhos
Basing 4D–0–0



4D

Get Actual
TRANSFORMER DELIVERIES
—not just "promises"!

Are transformer deliveries your production "bottleneck?" Not when you order from Ferranti — because Ferranti delivers when scheduled — whether you order a stock model or a special job. Large or small orders . . . *deliveries*, not delays—and quality of the finest.

And in addition—remember only Ferranti gives you:

(1) 60 YEARS EXPERIENCE
(2) UNMATCHED PRESTIGE
(3) EXPERIENCED ENGINEERING
(4) ADEQUATE EQUIPMENT
(5) THE ECONOMY INHERENT IN QUALITY PRODUCTS

Write to Ferranti for a quick solution to your transformer problems.

FERRANTI PRODUCTS

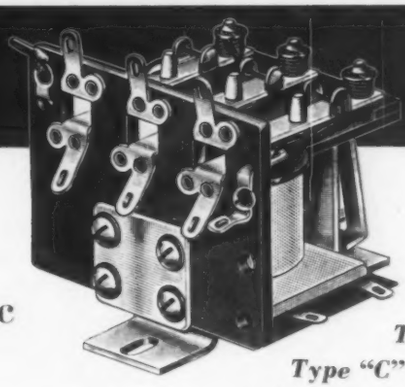
Transformers for every electronic, sound, communication, industrial, and laboratory use — miniature aero transformers for aircraft and portable work — high power plate and filament transformers — filters, equalizers, modulation sets, rectifiers, etc. — electrostatic voltmeters, portable voltmeters, ammeters, phase rotation indicators, special testing equipment, and numerous other instruments.

Ferranti ELECTRIC INCORPORATED

R.C.A. BUILDING, NEW YORK, N.Y.

G-M

TYPE "C"
Electro-Magnetic
RELAY
Small, Economical, Durable



This is Type "C" three pole, double throw, electro magnetic relay

If your requirements call for small 1, 2, 3 or 4 pole, single or double throw relays, we believe you will find the new G-M Type "C" relay a superior relay for your purpose. It possesses those essential elements of long mechanical and electrical life.

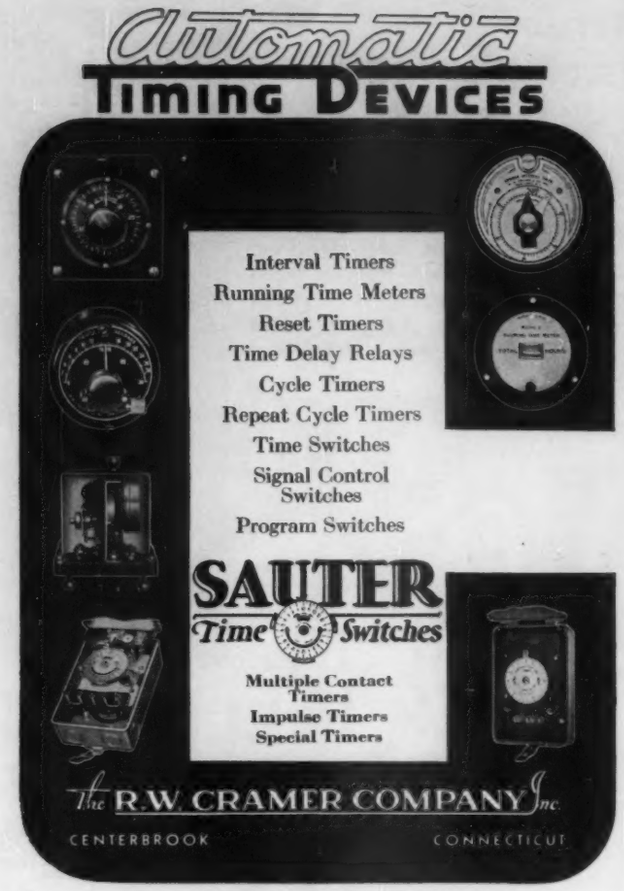
Type "C" relays are available with a variety of contact materials for different load requirements. The design provides self-cleaning wiping action in normally open or closed contact positions. Machine assembly of parts provides economical, low-cost production.

Our recently completed factory provides large production facilities, assuring prompt service.

Write Today For Bulletin No. 607

A detailed description of the Type "C" Relay is necessary in order to appreciate fully its outstanding qualifications and possibilities. Send for Bulletin No. 607 now.

G-M LABORATORIES INC.
4313 NORTH KNOX AVE. CHICAGO, U.S.A.



THERE'S ALWAYS AN EASY WAY TO DO A JOB

PRESTO 10-A TURNTABLE
Price, complete chassis ready for use, $140.00

● The Presto 10-A turntable proves the point. It has only 2 moving parts. . . A rubber-rimmed turntable, dynamically balanced, driven by a steel step-pulley on the motor shaft. A lever changes the speed instantly from 78 to 33⅓ RPM. It's the simplest drive mechanism of any table made . . . inexpensive, too . . . maintenance averages $2.00 a year. As for performance, speed accuracy .4%, speed regulation .2%, vibration noises 50 db below zero level (.006W). Decide now to improve your transcription broadcasts. Replace your turntables with the new Presto 10-A. Catalog sheet on request.

PRESTO
RECORDING CORP.

NEW YORK • 242 WEST 55TH STREET
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Cleveland, Maine 1565 • Dallas, 37093 • Hollywood, Hillside 9133
Kansas City, Victor 4631 • Montreal, Wellington 6967 • San Francisco, Yukon 0231 • Seattle, Seneca 2560 • Washington, D. C., District 1640

Type 45

POWER amplifier triode, filament type, ST-14, glass envelope, seated height 4 1/16 inches (max), 4-pin base.

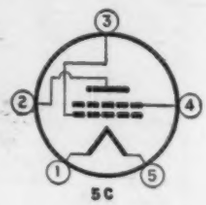
E_f = 2.5 v
I_f = 1.5 amp
E_b = 250 v
E_c = − 50 v
I_b = 34 ma
R_i = 3900 ohms
P_o = 1.6 watt
Basing 4D–0–0

4D

Type 46

DOUBLE-GRID power amplifier, filament type, ST-16 glass envelope, seated height 4¾ inches (max), 5-pin base.

E_f = 2.5 v
I_f = 1.75 amp
E_b = 250 v
Grid No. 2 tied to plate
E_c = − 33 v
I_b = 22 ma
R_i = 6400 ohms
P_o = 1.25 watt
Basing 5C–0–0



5C

Type 47

POWER amplifier pentode, filament type, ST-16 glass envelope, seated height 4¾ inches (max), 5-pin base.

E_f = 2.5 v
I_f = 1.75 amp
E_b = 250 v
E_{c2} = 250 v
E_c = − 16.5 v
I_b = 31 ma
I_{c2} = 6.0 ma
R_i = 7000 ohms
P_o = 2.7 watts
Basing 5B–0–0

5B

Type 48

POWER amplifier tetrode, heater type, ST-16 glass envelope, seated height 4¾ inches (max), 6-pin base.

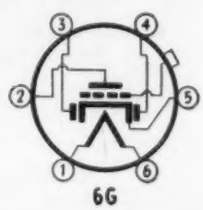
E_h = 30.0 v
I_f = 0.4 amp
E_b = 125 v
E_{c2} = 100 v
E_c = − 22.5 v
I_b = 52 ma
I_{c2} = 12 ma
R_i = 1500 ohms
P_o = 3.0 watts (9%)
Basing 6A–0–0

6A

Type 55

DUODIODE, triode amplifier, heater type, ST-12 glass envelope, seated height 3 31/32 inches (max), 6-pin base.

E_f = 2.5 v
I_f = 1.0 amp
E_b = 250 v
E_c = − 20 v
I_b = 8 ma
μ = 8.3
g_m = 1100 μmhos
Basing 6G–0–5



6G

DeJUR
Instruments

FOR
DEPENDABILITY
"OUR WATCHWORD"

MODEL
212

ACCURACY
"Tested after every assembly operation"

MODEL
312

STYLING
"EASY ON THE EYES"

DeJur's 100% self-contained plant assures you prompt delivery schedules. Why not write for complete information today?

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E_f = 6.3 v
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E_c = − 13.5 v
I_b = 5.0 ma
μ = 13.8
g_m = 1450 μmhos
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5A

Type 79

CLASS B twin triode amplifier, heater type, ST-12 glass envelope, seated height 3 13/32 inches (max), 6-pin base.

E_h = 6.3 v
I_h = 0.6 amp
BOTH TRIODES
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E_c = 0 v
I_b = 10.5 ma
R_l = 14,000 ohms (plate to plate)
P_o = 8.0 watts
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6H

Type VR-90

GAS-FILLED cold-cathode voltage regulator, ST-12 glass envelope, seated height 3 7/16 inches (max,, 7-pin octal base.

E (starting) = 125 v (min)
E (operating) = 90 v
I (operating) = 10 ma (min)
= 30 ma (max)
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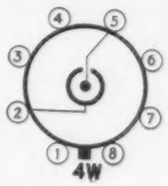

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Type VR-150

GAS-FILLED cold-cathode voltage regulator, ST-12 glass envelope, seated height 3 7/16 inches (max), 7-pin octal base.

E (starting) = 180 v (min)
E (operating) = 150 v
I (operating) = 5 ma (min)
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GAS-FILLED cold-cathode voltage regulator, S-17 glass envelope, seated height 5 inches (max), 4-pin base.

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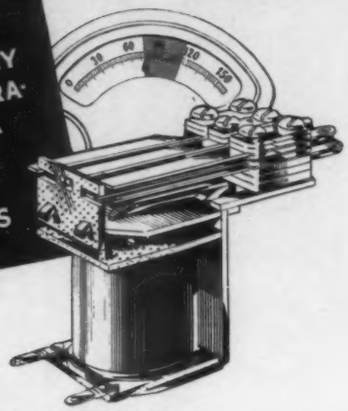

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I_f = 0.3 amp
E_b = 250 v
E_c = − 20 v
I_b = 8 ma
μ = 8.3
g_m = 1100 μmhos
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6G

Type 89

POWER amplifier pentode, heater type, ST-12 glass envelope, seated height $3\frac{3}{32}$ inches, 6-pin base.

E_f = 6.3 v
I_f = 0.4 amp
E_b = 250 v
E_{c2} = 250 v
E_c = −25 v
I_b = 32 ma
I_{c2} = 5.5 ma
R_l = 6750 ohms
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DETECTOR amplifier triode, filament type, ST-14 glass envelope, seated height $4\frac{1}{16}$ inches (max), 4-pin base.

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I_f = 0.25 amp
E_b = 180 v
E_c = − 13.5 v
I_b = 7.7 ma
μ = 8.5
g_m = 1800 μmhos
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4D

Type 1231

TRIPLE-GRID amplifier, heater type, integral glass envelope-base, seated height $2\frac{5}{8}$ inches, 8-pin base.

E_f = 6.3 v
I_f = 0.45 amp
E_b = 300 v
E_{c2} = 150 v
Cathode-bias resistor 200 ohms
I_b = 10.0 ma
I_{c2} = 2.5 ma
g_m = 5500 μmhos
r_p = 0.7 megohm
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Type 1851

TRIPLE-GRID amplifier, heater type, metal envelope, seated height $2\frac{1}{16}$ inches (max), 8-pin base.

E_f = 6.3 v
I_f = 0.45 amp
E_b = 300 v
E_{c2} = 150 v
Cathode-bias resistor 160 ohms (min)
I_b = 10.0 ma
I_{c2} = 2.5 ma
g_m = 9000 μmhos
r_p = 0.75 megohm
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THE ELECTRON ART

A twin-channel single-sideband transmitter, a method of determining acoustical properties of auditoriums using models, photoelectric control of Bessemer converters, a ballistic speedmeter, and an electronic a-c bridge are among the subjects reviewed this month

A Twin-Channel Single-Sideband Transmitter

A TWIN-CHANNEL single-sideband radio transmitter is described by K. L. King in the March 1941 issue of the *Bell Laboratories Record*. This type of transmitter has been under development for some years and at the present time a number of them are in use in trans-oceanic telephone circuits. An interesting feature of the single-sideband transmitter is that it can transmit simultaneously two independent single sideband signals. The accompanying carrier is transmitted at reduced amplitude so that the major portion of the output is in the two sidebands. When the two sidebands are used as separate channels, the voice-frequency bands extend from 250 to 3,000 cycles per second but one of them is translated to a band from 2250 to 5000 cycles per second by a modulator and filter system in the terminal equipment preceding the transmitter. Thus the two telephone channels are separated by 2500 cycles per second, into which the major products of distortion fall. Therefore the crosstalk between channels is substantially reduced.

In addition to providing two channels for single-sideband transmission, a single channel is provided from 100 to 6000 cycles per second. This single channel may be used for service to stations which are not equipped with single-sideband reception. A schematic diagram of the transmitter is shown in the accompanying diagram.

Three modulating steps are used. The first two conversion frequencies, 125 and 2500 kc are both derived from a single 625 kc oscillator. The 125 kc may be obtained with a multivibrator and the 2500 kc through a harmonic generator. For two-channel single-sideband transmission, two voice bands are supplied to modulators 1A and 1B together with the 125 kc conversion frequency. These are balanced modulators, the output of each consists only of two sidebands of 125 kc, the carrier itself being suppressed by the balanced circuit. The two filters following the modulators select opposite sidebands, filter A the upper, and filter B the lower. The two single sidebands passed by these filters combined with a reduced carrier form the input to the second modulator, which uses the 2500 kc conversion frequency. The upper sideband of this modulation is selected by the following filter and passed to the third modulator.

The transmitter is designed for operation on any of six predetermined frequencies between 4½ and 22 megacycles and the third conversion frequency must be chosen to give the desired final frequency. Five amplifier stages follow the third modulator and give the transmitter an output of 2 kilowatts for the envelope peak. As used at Lawrenceville, N. J., the transmitter drives a water-cooled amplifier with an envelope peak output of 60 kilowatts.

• • •

Determination of Acoustic Characteristics of Halls By Optical Experiments

A MEANS OF DETERMINING the acoustic properties of auditoriums by means of optical experiments with small models is described by R. Vermeulen in the November 1940 issue of *Phillips Technical Review*. The principle of the model used for this purpose is shown in Fig. 1. The part of the auditorium occupied by the audience is left open because the sound which is incident on the audience is almost completely absorbed. The light source is placed in the position of the stage, orchestra, or other source of sound.

If a photographic plate or a frosted glass plate is placed in the opening in the audience space, it will receive the direct light from the lamp and the light reflected by the ceiling and walls. The distribution of the intensity of illumination over the floor space will correspond to the distribution of the intensity of sound over the audience. This is true as long as the propagation of sound takes place according to the

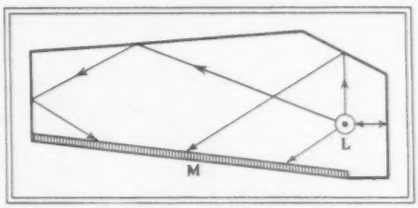

Fig. 1—Diagram of the model auditorium used in determining acoustical characteristics

rules of geometric optics. This is true for high frequencies whose wavelengths are small compared with the dimensions of the surfaces at which the sound is reflected. For low frequencies, however, it does not hold. A further restriction of the fidelity of the model lies in the fact that it is almost impossible to make the optical reflection coefficients as large as the acoustic reflection coefficients of many ordinary wall coverings. However, if the experimenter is primarily concerned with in-

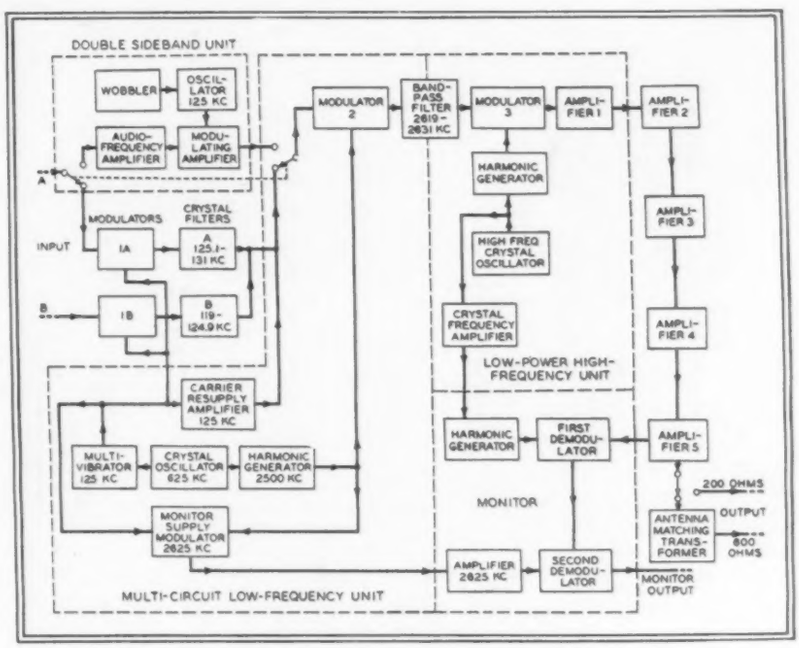

Diagram of the transmitter capable of transmitting two single-sideband signals simultaneously

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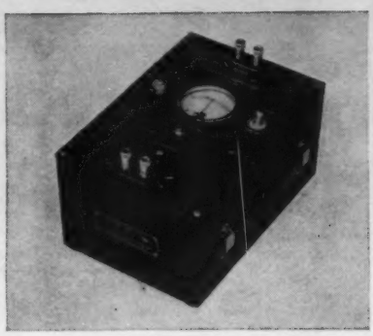

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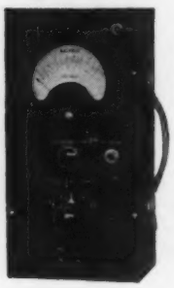

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telligibility the optical models can be successfully used.

In order to determine the directional distribution of the radiation which is incident upon a given point, a camera obscura is used. This is a small cube with an edge of 1 centimeter, with small holes in the centers of two opposite faces, and a piece of photographic paper, light sensitive on both sides, is placed halfway between these

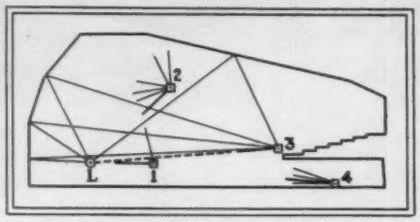

Fig. 2—Model of the broadcasting studio at Hilversum under typical operating conditions

two faces. When the camera is placed at a spot in the model at which one desires to investigate the directional distribution of the sound, an image will be formed on both sides of the photographic paper from which can be judged the main direction of the light incident upon the front and rear of the camera obscura. By making three exposures with the holes in the camera first front and back, then right and left and then top and bottom, a complete picture can be obtained of the directional distribution of the sound at the spot investigated. The picture can be made very clear by pasting the photographs obtained upon a cube so that the line joining the center of the cube and a blackened point of a photograph pasted on one side corresponds to the direction of the ray which caused the blackening. Figure 2 shows a cross-sectional diagram of the broadcasting studio in Hilversum, Netherlands, with a camera obscura for each of the four points indicated.

• • •

Daylight Measurement of Cloud Ceiling by Photoelectric Means

INFORMATION ON THE HEIGHT of the cloud ceiling, vitally important to airplane pilots, may now be obtained during the day as well as at night by a method described in "Daytime Photoelectric Measurement of Cloud Heights," by Maurice K. Laufer and Laurence W. Foskett in the May 1941 issue of *Electrical Engineering*. In the United States and Canada, the meteorological services use ceiling projectors at airports to determine the height of ceilings at night. The intense beam of light from such a projector forms a conspicuous spot on the bottom of the cloud and a simple optical instrument at some known distance from the projector is used to measure the angle between the line of sight to the spot and the line to the projector. The altitude

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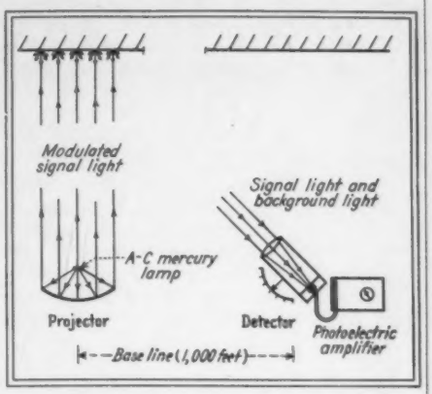
of the cloud is easily computed by multiplying the distance from the optical detector to the projector (on a horizontal line) by the tangent of the angle between the line of sight and the horizontal.

To make this measurement in daylight, a modulated light beam and a photoelectric detector are used. The accompanying figure shows the equipment. The projector consists of a 24-inch parabolic mirror with an a-c operated high intensity mercury-vapor lamp. The modulation of the beam is approximately 95 per cent and has a frequency of 120 cycles per second when the lamp is operated on 60-cycle current. A phototube and a 8-inch lens are used to detect the modulated light signal after reflection from



Method of measuring cloud height in daytime

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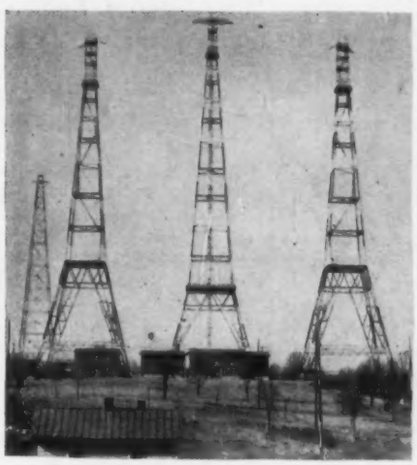
FAMILIAR LANDMARK TO GO



Towers of the Arlington radio station, NAA, which have made radio history for the past thirty years, are to be torn down since they are a menace to modern aviation and since long wave communication is of diminishing technical and commercial importance. Two towers are 450 feet high, while the third is 600 feet high

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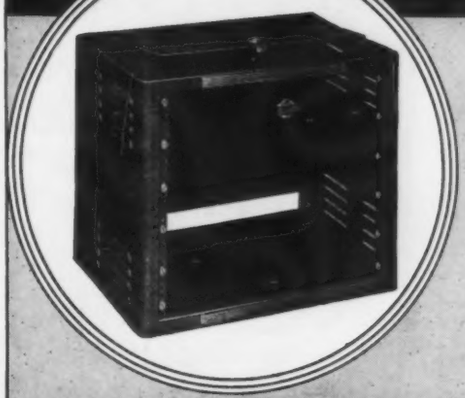

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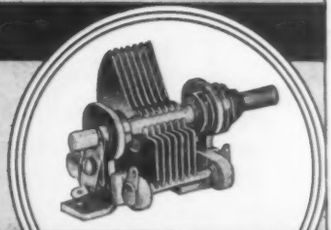

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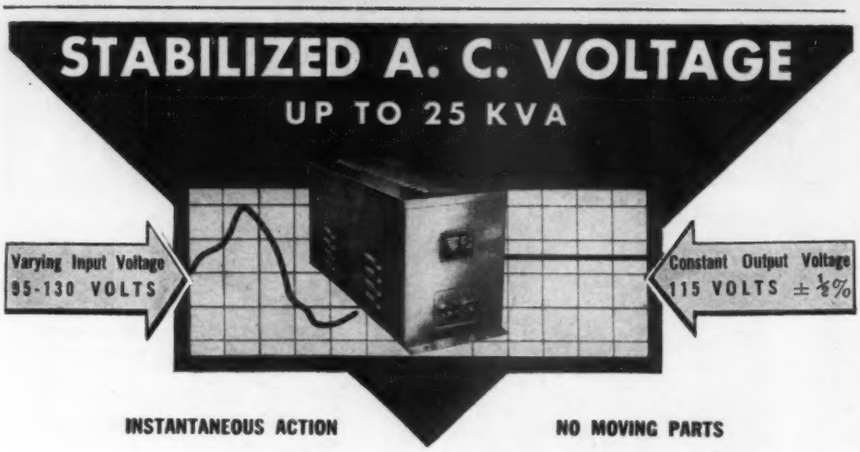

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the cloud ceiling. The signal is amplified by a five-stage 120-cycle resistance-capacitance tuned amplifier. In practice the base of the cloud is scanned by the detector until the output meter indicates that the light signal is being received. The computation of altitude is made as in the night time measurement.

In order to keep the average phototube current produced by the background light at a minimum, the optical system of the detector was designed to pick up an area on the ceiling no larger than the spot illuminated by the projector. A diaphragm was located at the focus of the 8-inch glass lens and a type 929 phototube was placed immediately behind the diaphragm. This tube was chosen because its response is high in the spectral region where the mercury lamp emits most of the energy usable in a glass system. The amplifier used has an effective band width of 100 cycles per second which is narrow enough to make the minimum detectable signal dependent only on the period of the output meter if the background noise results from statistical causes.

By the use of this instrument dark overcast clouds at an elevation of 9,000 feet have been detected readily during the daytime. For cumulus clouds illuminated by direct sunlight and having elevations up to 4,000 feet, the detection is positive. By using battery-operated incandescent lamps to produce background light, a signal light of about 5×10^{-7} times the background light may be detected.

• • •

Acoustic Control for the Concert Stage

CONCERT SINGERS and instrumentalists are somewhat at a loss when they perform in large concert halls and auditoriums because the acoustic conditions are such that they are unable to hear themselves as they would in a smaller chamber. As a result the performers complain of an inability to relax, a feeling of being ill at ease, of having low vocal efficiency, of forcing the voice in an effort to project and using a higher speed than is best for the music in an effort to get more volume and fill up the house. A method has been devised to help concert performers and has been described in the January 1940 issue of the *Journal of the Acoustical Society of America* by Harold Burris-Meyer.

Several years ago Mr. Paul Robeson discovered that if he stood in front of a loudspeaker of a public address system being used in a concert, he enjoyed some of the desirable acoustic conditions usually associated with a small studio. Using this as a starting point, experiments were conducted to determine the best conditions of playing back the music to the artist so that he may perform under the most favorable conditions. It was discovered that if

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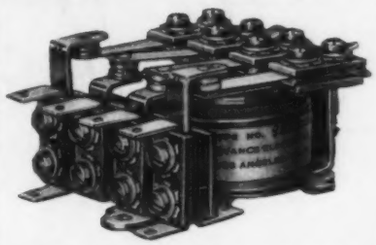

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1260 W. 2nd St., Los Angeles, Calif.
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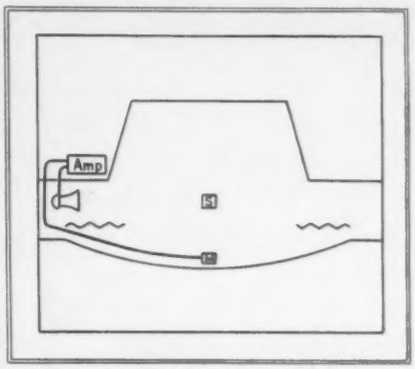
the artist hears the reproduced sound a little later than the original one, he is perfectly satisfied that he is hearing himself even though the reproduced sound be of much less intensity than the original sound. It seems entirely logical that time difference should be satisfactory since time difference is a characteristic of long reverberation or room resonance. A time difference is achieved by placing a directional speaker 50 feet or more from the artist,



Arrangement of sound system used to assist concert artist

or by pointing it at a surface which will reflect the sound to the artist so that the path from speaker to artist is more than 50 feet. Successful operation of this system requires that no reproduced sound is heard by any part of the audience.

Experiments involving frequency control at low intensity have shown that the presence or absence of low frequencies is not apparent except in the case of loud reproduction. Over-emphasized frequencies of 1500 cps and up can be heard at low intensity. Also, low frequencies lack directional characteristics and even with a highly di-

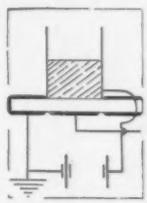
• • •

"SPARKO" RESPONDS

In reply to words spoken into a microphone, Sparko, a robot dog, recently exhibited at the Electric Living Show in Chicago, barks, walks, sits up, wags his tail, and does other tricks. We show Sparko sitting up and barking. Perhaps in his own language his barking means, "Science is certainly wonderful"

"dag's" *versatile films*

RESISTANCES: Colloidal graphite is a resistance material widely used in volume controls, tone controls, grid leaks, and similar types of fixed and variable resistors



TEST SPECIMENS: This product also has many advantages over common foils for measuring constants of insulating substances.

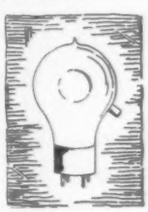
VACUUM TUBES: Films formed with "dag" colloidal graphite discourage secondary and undesirable primary emission emanating from vacuum tube elements. Electrostatic shielding may also be accomplished.

THERMOPILES: Radiation collectors utilize the heat conducting and high "black-body" values of "dag" deposits.

CATHODE RAY ENVELOPES: Interior walls coated with similar films provide "gettering", focusing, intensifying, and shielding action in television tubes.

EVACUATED DEVICES: Shields, guard rings, "cat's whisker" contacts, conductive cements, and special electrodes or contacts are formed conveniently with "dag" dispersions.

PHOTOELECTRIC CELLS: Graphite surfaced electrodes absorb free alkalies and alkaline metals in photoelectric cells. No selenides result when the "dag" product is used in the selenium types.



The above statements should not be considered as recommending the use of colloidal graphite in violation of any valid patents which may exist.

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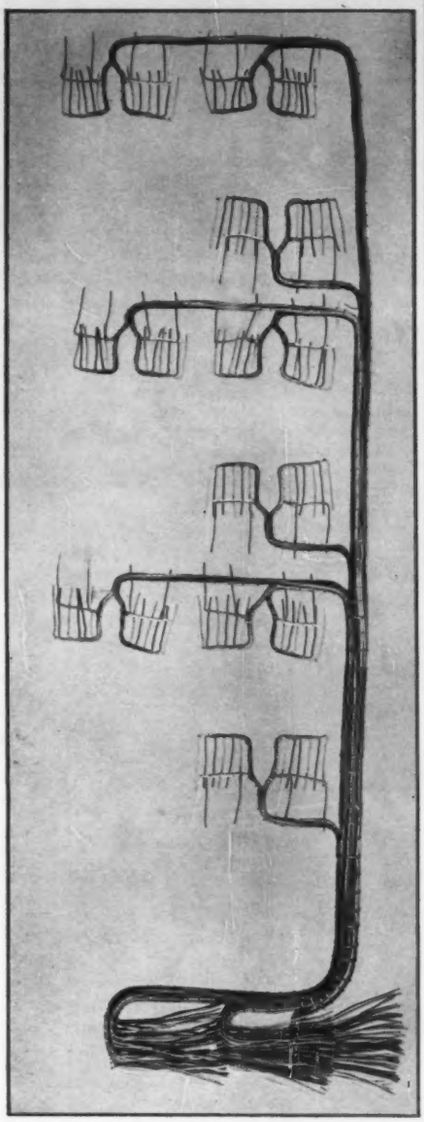

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rectional speaker will slop over into the audience if they have to travel more than 50 feet before reaching the artist. High frequencies are directional enough to be kept away from the audience and are absorbed readily by the furnishings of the stage.

The technique is fully effective when the sound level, at the position of the artist, is not measurably affected by turning the system on or off, whether the measurement be made at flat response or weighted for loudness in conformity with the ear curve. A single speaker can effectively cover a sharply defined stage area of approximately 200 square feet. A single footlight microphone can respond effectively to music emanating from any point within that area and a level set well below the point of regeneration for an empty house is safe and more than adequate for a full house.

• • •

Phototube Control for Bessemer Steelmaking

THE CONTROL OF BESSEMER steelmaking by means of phototube circuits was described by H. K. Work before the February 1941 New York meeting of the American Institute of Mining & Metallurgical Engineers. This method gives a rapid and quantitative indication of changes in the flame which are recorded graphically for each flow and the interpretation of these curves was discussed as well as the procedure for applying the method for control. The

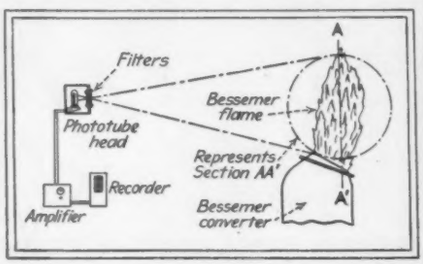

Fig. 1—Arrangement of phototube equipment in relation to the flame of the Bessemer converter

diagram of Fig. 1 shows the position of the phototube equipment in relation to the Bessemer converter flame and the approximate field of view of the phototube. The preferred field of view encloses substantially the whole flame at its maximum size. Naturally this also includes areas not covered by the flame, but these do not interfere with the flame reading, if suitable precautions are taken in locating the equipment, because of the relatively great intensity of the radiation of the flame. The distance of the phototube unit from the converter in the installation under discussion is approximately 60 feet. The exact location is controlled by the mechanical conditions in a particular mill such as: (1) convenience of mounting; (2) interference by cranes or

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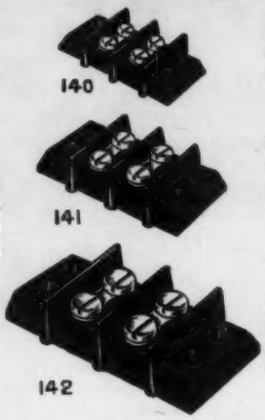

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smoke; (3) exclusion of other Bessemer flames, the sun, and the sky from the field of view; and (4) ease of servicing.

There are three phototubes inclosed in the viewing unit and the output of the three tubes is amplified and recorded. In order to use this record most effectively it is desirable to employ filters on the viewing unit. A number of different filters and combinations of filters were tried, and the one finally selected as the most suitable on the basis of present knowledge can best be described as a heat-absorbing filter together with an ultraviolet-absorbing filter. This combination is now used in regular production. The equipment used is shown in Fig. 2 and includes the phototube viewing unit using the three phototubes, an amplifier and the recording unit.

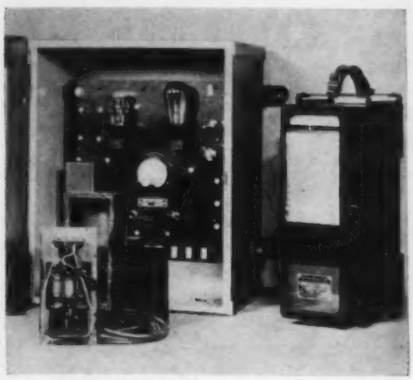

Fig. 2—Phototube head, amplifier and recorder used in Bessemer converter control

A typical flame curve is shown in Fig. 3. The point marked *A* is the start of the blow and the direction of increasing time is from right to left. For various studies involving blowing, time is an important reference point. The period of low flame intensity marked *AB* is generally referred to as the silicon blow because to a large extent the silicon burns out during this period and *BE* is called the carbon blow for similar reasons. The maximum height of the curve *CD* furnishes information about the metal temperature. This indication of relative temperature is one of the benefits from the phototube control because of the great effect of temperature on the nitrogen content of the steel.

As the flame intensity falls at the end of the blow an arrest occurs. This may vary in shape and position depending on the steelmaking practice and the filters used in the flame-control equipment. It has become accepted practice to refer to the beginning of this arrest in the curve as the end point because it has served as a guide to indicate when the blow was ready to turn down. The fact that this arrest occurred regularly at about the same position when blowing conditions were constant made it natural to consider this a natural reference point.

The point *F* is generally referred to

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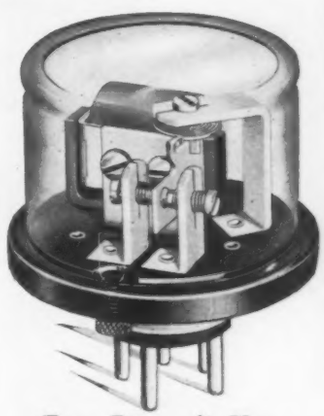

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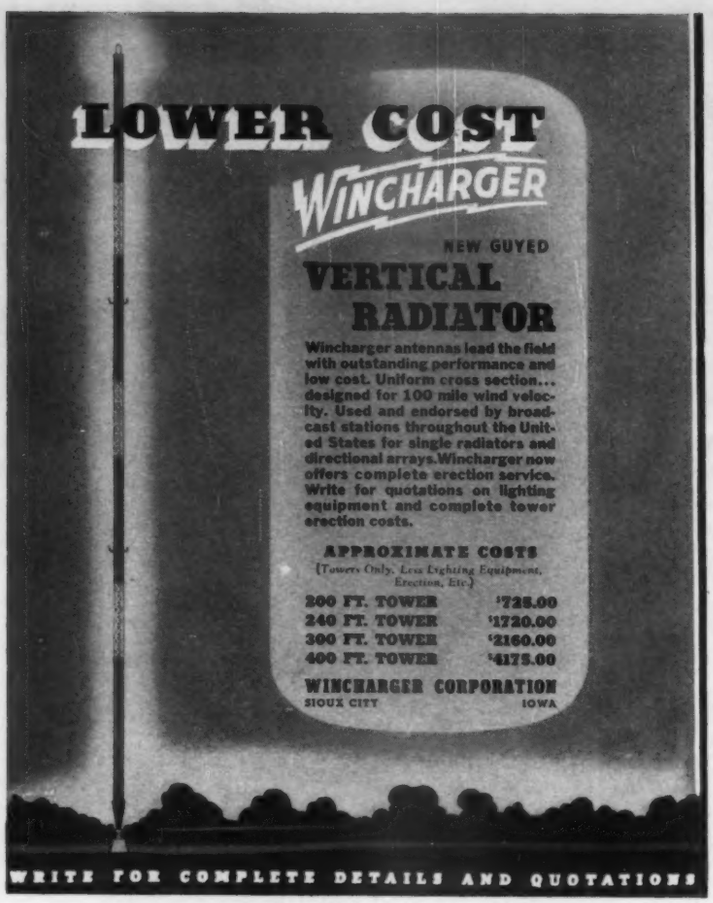
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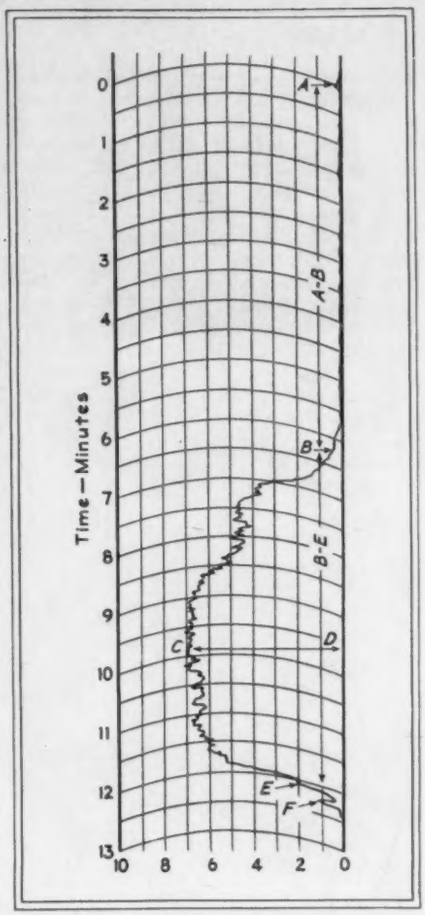

Fig. 3—Typical record of luminous energy content of Bessemer flame produced by photoelectric equipment

as the flashback or end of the blow and is caused artificially or by the converter flame impinging against the shield on the walls of the building. This is a valuable reference point for checking the afterblow and a special effort is made to select a filter combination that shows this clearly.

This forms the basis of controlling the Bessemer furnace to give a more uniform product and also a means of producing various types of Bessemer steel. This development promises much in bringing back Bessemer process as an important method of producing steel and points the way for the use of the electronic method in other heavy industries.

• • •

A-C Bridge for Voltage and Phase Determination

AN INSTRUMENT for the determination of a-c voltages and phase relations is described in an article by J. R. Barnhart, appearing in the April 1941 issue of *Instruments*. A rugged d'Arsonval galvanometer is connected to an a-c bridge network by an electronic circuit so that the operation is very much the same as with the Wheatstone bridge, except that the galvano-

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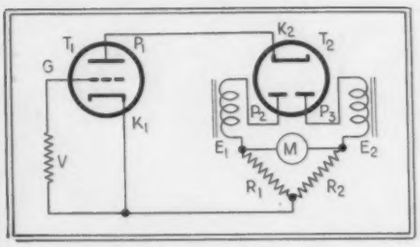

Fig. 1—Diagram showing the basic circuit of the voltage detecting element of the a-c bridge

meter impedance is greatly increased. This instrument recognizes not only the presence or absence of a voltage, but also its phase displacement. The fundamental circuit of this bridge is shown in Fig. 1. T_1 is a triode tube whose plate is connected to the cathode at K_2, a full-wave rectifier tube. Connections are made so that when P_2 has a positive voltage applied, the voltage of P_3 is negative. R_1 and R_2 are resistances of equal value and M is a d'Arsonval galvanometer. When the voltage of P_2 is positive, current flows from P_2 through K_2, P_1, K_1, R_1, E_1 and back to P_2. Part of the current is shunted through R_2 and M, causing the galvanometer to tend to deflect to one side; for example, to the left. When P_3 is positive, current flows in the direction P_3, K_2, P_1, K_1, R_2, E_2 and back to P_3. A portion is shunted through R_1 causing the galvanometer to tend to deflect to the right. Because of the inertia of the moving element of the galvanometer, the pointer cannot follow the alternating current and therefore to the eye the pointer is motionless.

If a potential is applied to grid G in phase with E_1, the current tending

• • •

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to move the pointer to the left will be increased. Conversely, if the potential on G is in phase with E_2, the pointer will move to the right. If the potential on G lags E_1, and leads E_2 by 90 electrical degrees, or vice versa, the

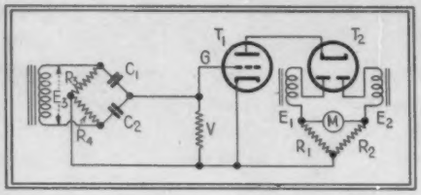

Fig. 2—Circuit of a simple a-c bridge

pointer will not deflect. For any intermediate angle between G and E_1 or E_2 the deflection is proportional to the cosine of the phase angle. Whether the phase is leading or lagging can be determined by the direction of deflection. Figure 2 shows the circuit diagram of a simple bridge. E_1, E_2 and E_3 are all windings on the same trans-

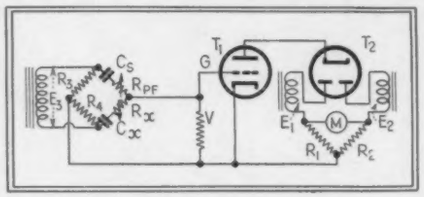

Fig. 3—Circuit for measuring power factor

former. There they are all in phase. R_3 and R_4 are adjusted until zero deflection occurs. Then $R_3/R_4 = C_x/C_1$ and there is no voltage across V resulting in zero deflection of the galvanometer.

The method of measuring power factor is illustrated in Fig. 3. The potentials of E_1 and E_2 are adjustable in phase relative to E_3. C_s represents a standard capacitor having zero power factor. C_x represents the unknown capacitor with its equivalent series resistance, R_x. R_3 and R_4 are adjusted for zero deflection of M. In this case zero deflection occurs because the power factor of a voltage between G and E_1 is zero. This instrument can be used to measure extremely small inductances and capacitances.

• • •

Static Electricity on Rubber-Tired Vehicles

A DISCUSSION of the fundamental properties of static electricity and experiments conducted upon rubber-tired vehicles by Robin Beach appears in the May 1941 issue of *Electrical Engineering*. The voltages which result from rapidly moving belts, conveyors, paper stock, fabrics and similar materials, as well as those which originate at nozzles from rapidly issuing steam and

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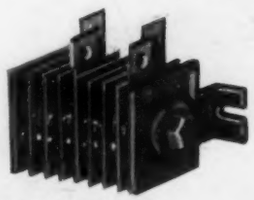

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other gases, attain amazingly high values under favorable conditions. In various ways, voltages ranging from a few thousand up to as high as 75,000 volts have been recorded, and in some cases with large quantities of stored charge ready to arc to ground. Surprising as it may seem a person can generate a stored charge in his body at a voltage as high as 10,000 volts by scuffing over a woolen rug on a dry, cold day and upon discharge, can cause a spark of sufficient intensity to light

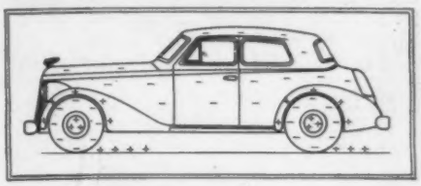

Fig. 1—Typical distribution of static charges on an automobile

a cigarette lighter or a gas jet. Even this commonly known phenomenon can be potentially dangerous.

A great many fires and explosions are known to have originated from the sparks resulting from high-voltage discharges on gasoline trucks, oil trucks, and carriers of explosives and of other inflammable materials. Many people are surprised to learn that an empty gasoline truck, in which the residual vapors are thoroughly admixed with air, is no less of an explosion menace on highways than a load of dynamite. Even the static-electricity shocks from buses and automobiles should not be considered lightly since, in cases of impaired health, they have

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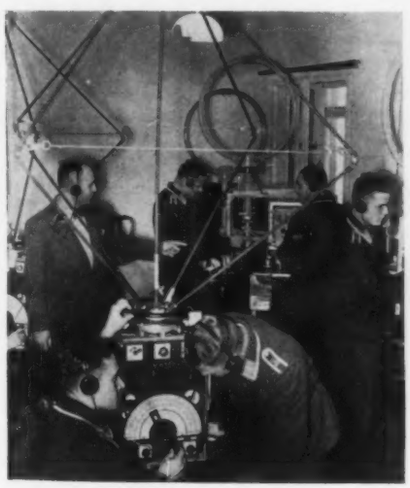
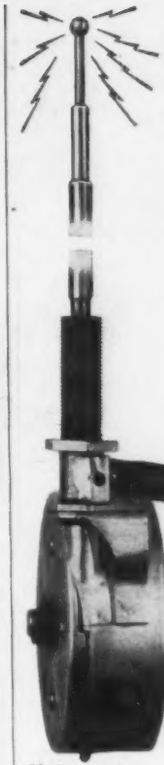
RADIO TRAINING IN GERMANY



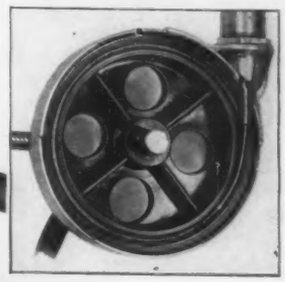
The training of radio operators goes on with grave seriousness. Shown here are uniformed men in a school for training aircraft radio men, undergoing instruction in the operation of direction finding equipment



Photos courtesy of the Radiart Corporation, Cleveland, Ohio

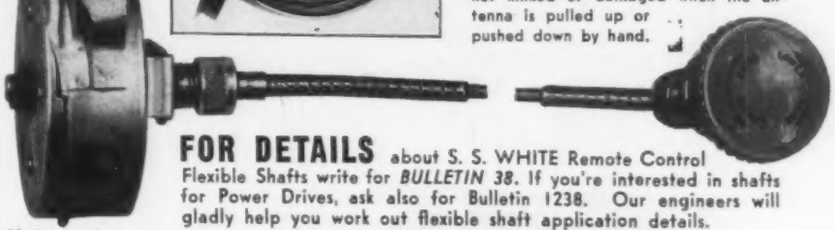
TELESCOPING ANTENNA operated with S. S. WHITE Remote Control Flexible Shafts

This is another in the long list of remote control problems to which S. S. WHITE Remote Control Flexible Shafts have supplied the answer. One shaft rotates the reel. The other, with a "push-pull" action, extends and retracts the telescoping antenna sections. Together they provide the smooth, easy operation characteristic of this particular type of S. S. WHITE flexible shafting, designed and built expressly for remote control.



The reel-rotating combination consists of Shaft No. 150L46, Metallic Casing No. 169A6 and their respective end fittings. It comes as a **complete unit** which can be attached or removed in a few seconds by means of the knurled coupling nuts on each end. This combination, available in any length, is suitable for many other remote control uses.

The push-pull shaft is No. 079R1. It is not kinked or damaged when the antenna is pulled up or pushed down by hand.



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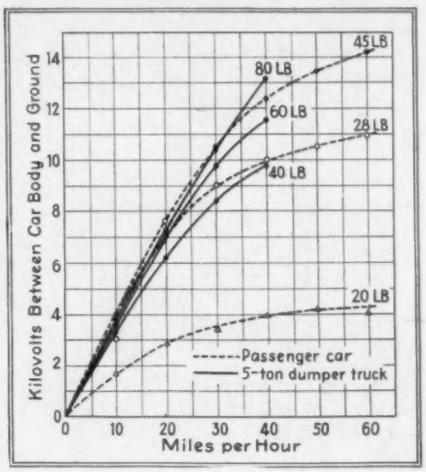

Fig. 2—Family of saturation curves for a passenger car and a dumper truck

gains electrons becomes negatively charged and the other, having lost electrons, becomes positively charged. The boundaries of the metallic substances are normally bombarded by the free electrons in their attempt to escape, a condition similar to the boundary restraint imposed by surface tension against the escape of atoms of a fluid. These contact voltages for metals range from a few tenths of a volt to about one volt. The surfaces that are firmly in contact are actually separated by distances of the order of molecular

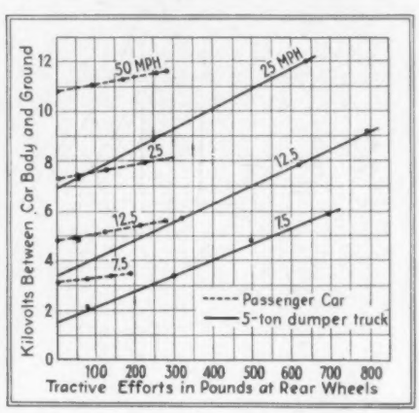

Fig. 3—Voltage-load curves made under conditions simulating heavy grades taken at constant speeds

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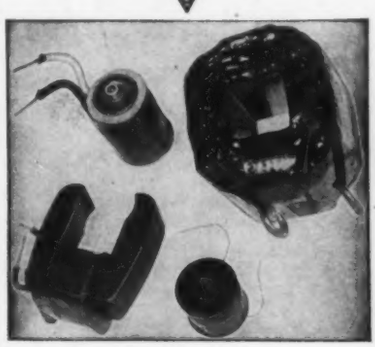

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proportions, approximately 1/100,000,000 inch or less. These orders of magnitude are important because they determine the values of voltages found in static electrification. As the two metals are separated, the stretching of the lines of force between the positive charges on one and the negative charges on the other causes the voltage between them to increase, tending to reunite the separated charges. Being free to move in the metal they move to the last remaining point of contact and the two metals lose all evidence of charge.

In nonconductors, however, the electrons are unable to move about freely and therefore cannot move to other points of contact. Therefore, they remain at the point where they originally entered the material and constitute a charge on that material.

The author describes a number of tests with a pleasure car and a 5-ton dumper truck, both on the highway and on a dynamometer proving stand. The results of these tests are shown in Figs. 2 and 3. Figure 2 is a family of voltage saturation surves for a Ford car and a 5-ton truck. Figure 3 shows the voltage-load curves for the passenger car and the truck under conditions which simulate the climbing of steeper and steeper hills at constant speed.

Measurements have been taken of the capacitance of pleasure cars with respect to ground wherein the metal of the car body is considered as one plate of the capacitor and the earth the other, with the dielectric or insulation between as a complex composite of the intervening air and the rubber tires. These values range from 500 to 650

• • •

WIRE COMMUNICATION TAUGHT AT FORT MEADE

Non-commissioned officers of the 29th Division take a course in wire communications as part of their regular army training at Fort Meade. Sgt. L. E. Luke, Sgt. Leonard Keegin, and Corp. William Millward (left to right), are setting up a field communication switchboard

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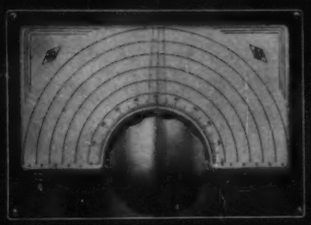

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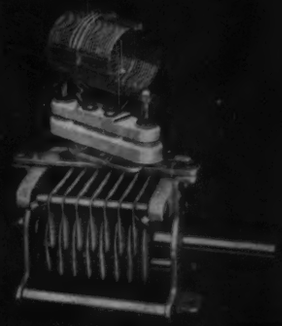

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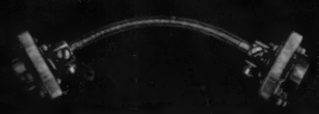

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micromicrofarads. For large trucks, buses and large tank trucks, the capacitance ranges between 950 and 1,500 micromicrofarads. The body capacitance of a person is about 120 micro microfarads.

Assume that a truck having a capacitance of 1,000 micromicrofarads and charged to a voltage of 20,000 volts, to be touched by a person whose resistance from fingers through his shoes to ground is 20,000 ohms. The current through his body is limited at the instant of contact by his resistance to a value of 1 ampere which reduces to ½ ampere in about 20 microseconds and to zero at about 60 microseconds, after which the truck is discharged. However, a current of 1 ampere might be dangerous even though of very short duration and might prove fatal if it should pass through the heart. Fortunately, people are normally well insulated from ground by their shoes which, when dry and soled with rubber, may have insulation resistance as high as 100 megohms.

In conclusion the author discusses a number of methods which have been used in an effort to combat this danger. None has been satisfactory because they do not recognize the fundamental method of generation of the electrification or where it occurs or how the charges are stored on the body of the vehicle.

• • •

Shielding of R-F Ammeters

AN ANALYSIS of the shielding of radio frequency ammeters is discussed in an article by J. D. Wallace in the January 1941 issue of the *Proceedings of the I.R.E.* When r-f current measuring instruments are operated at a point in a circuit at high radio-frequency potential with respect to ground or to other near-by low-potential objects, there is introduced an error due to a current

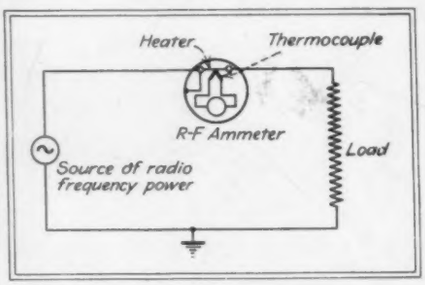
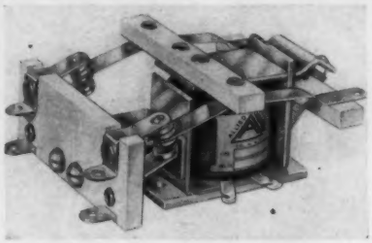


Fig. 1—Circuit showing use of a meter on the high side of an r-f load

which goes through the various parts of the instrument, including the thermocouple. In the circuit shown in Fig. 1 the instrument will effectively indicate as though the load were shunted by a small condenser. This hypothetical capacitance is termed the effective heater capacitance and the stray current indicated by the instrument will be designated as the heater charging current.

By means of the circuit shown in Fig. 2 a direct measurement of the heater charging current in an instru-



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ment may be obtained. Only one side of the circuit to the instrument under test has a metallic electrical connection to the source of r-f power and the circuit is completed through the effective heater capacitance path of the instrument. By use of this circuit no load circuit is associated with the instrument and no load current flows through it. Accordingly, the only read-

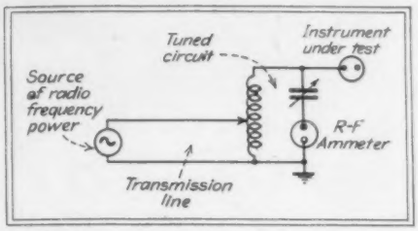

Fig. 2—Circuit for measuring heater charging current

ing which can occur on the instrument is due to its heater charging current. Obviously, it is necessary to connect the source of voltage to the low potential terminal of the instrument to avoid measuring the charging current associated with the other metallic parts of the instrument.

Figure 3 shows the structure of an instrument shield which has proved effective for the purpose of limiting heater charging current. An enlarged

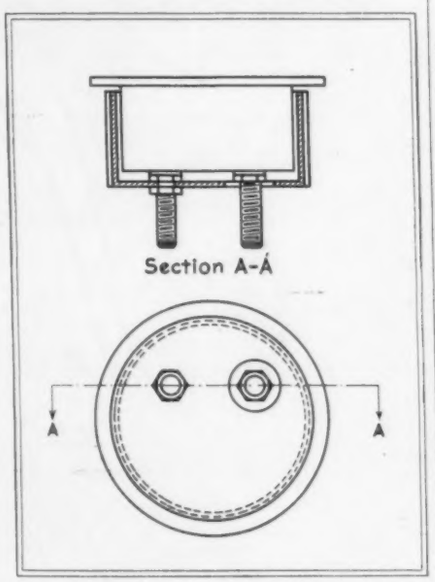

Fig. 3—Method of shielding an r-f meter to limit heater charging current

aperture is provided for making the other terminal accessible for connection into a circuit. The shield itself does not completely screen the inner mechanism of the instrument, but its shielding properties are augmented by the internal parts in a manner that the sensitive actuating members are quite well enclosed. The use of shields on instruments in the cases where high potential errors are of appreciable size has made it possible to make measurements with fairly small errors.

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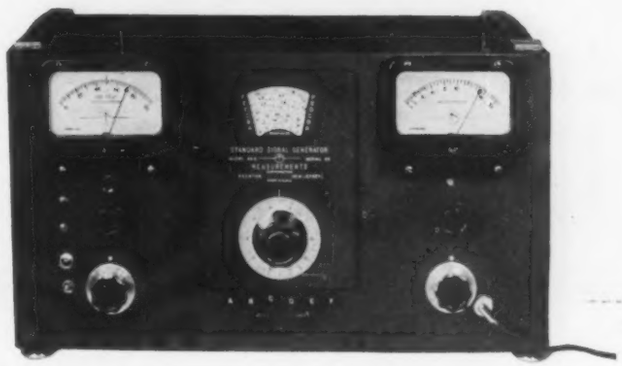

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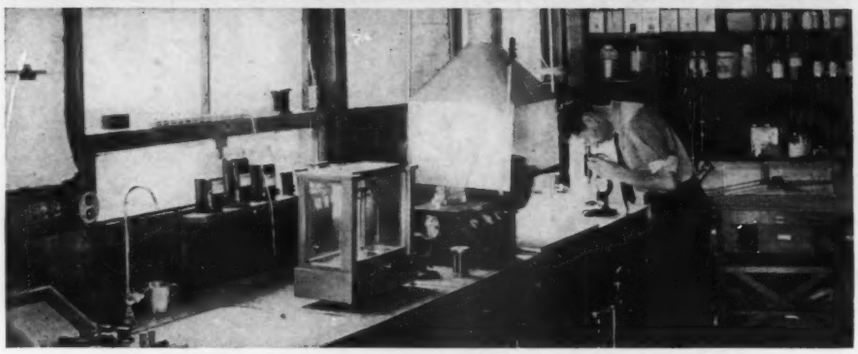

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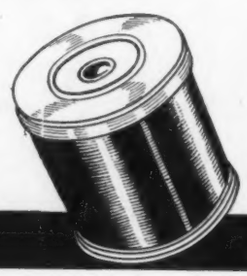

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Ballistic Speedmeter

A SPEEDMETER in which a ballistic galvanometer serves as the indicating and recording element is described by Herbert J. Reich and Hershel Toomim in an article entitled "A Ballistic Meter for Measuring Time and Speed" in the February 1941 issue of the *Review of Scientific Instruments*. A current is caused to pass through a thyratron tube and a ballistic galvanometer during the time a moving automobile passes

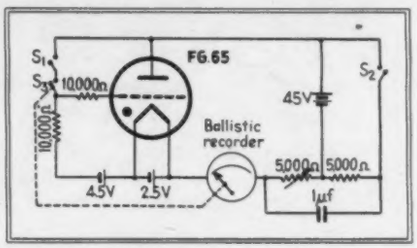

Fig. 1—Circuit of the ballistic speedmeter

between two fixed points. Either phototube relays or mechanical switches can be located at the fixed points to operate the circuit. The mass of the moving element in the galvanometer was increased so that one-quarter of its natural period exceeded the longest time to be measured. With a moving mass of about ¼ pound and a spring tension such that the period was two seconds, the graph of time intervals versus deflection for a constant current corresponding to an automobile speed over a 15-foot interval at 20 miles per

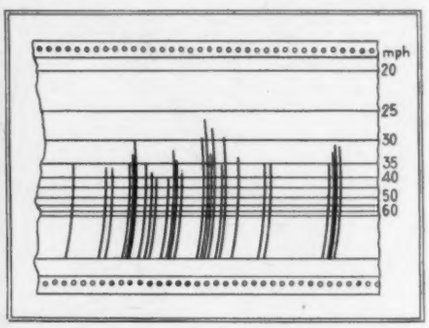

Fig. 2—Typical record of the speeds of automobiles passing the ballistic speedmeter

hour is approximately 0.61 second. The circuit of this speed meter is shown in Fig. 1.

After considerable experimentation, a heated recording stylus moving on waxed paper was used because of its neatness and simplicity. Since the stylus traveled over the paper at a fairly high velocity, it was necessary that it be made to ride very lightly on a taut strip. Figure 2 shows typical test results as recorded under normal traffic conditions on a city street. Switch S_3 is actuated by the moving element of the galvanometer to prevent acceptance of another indication until the stylus of the recorder is at rest.

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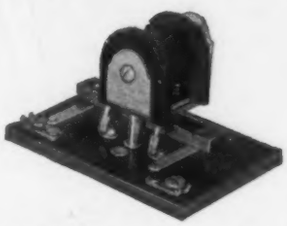

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Scanning Theory

THE FUNDAMENTAL THEORY of scanning is presented in a highly mathematical article by S. Sabaroff in the May 1941 isue of the *Journal of the Society of Motion Picture Engineers*. The theory of one dimensional and two dimensional scanning is developed to a point where it may be used in certain scanning operations. Also discussed is a three dimensional theory in which the probe may be thought of as a speck moving about in the region under investigation, and equations are developed so that a complete three dimensional scanning theory can be built up by their use. Examples of the use of the developed theory are given in two appendices.

• • •

Correction

IN THE APRIL ISSUE OF ELECTRONICS the editors inadvertently omitted the name of Mr. Lester Levy who collaborated in obtaining the measurements for the article "A Simple Television Preamplifier". Equipment for the measurements was made available through the courtesy of Radio Receptor Co.

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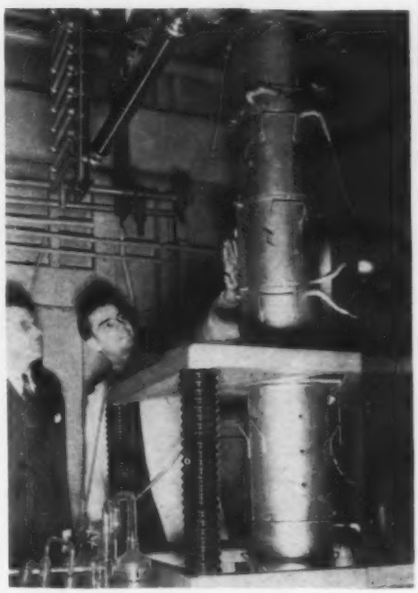
TURNING THE TABLES



Instead of following the usual practice and putting their x-ray tubes in an oven in the evacuating process, engineers of the General Electric X-Ray Corp. built the oven around the tube. A multi-section million-volt x-ray tube is shown here being baked at 500 degrees C., within a section cylindrical electric oven mounted vertically around the tube. Z. J. Atlee (left) and H. W. Brackney are shown with the tube in the Chicago plant

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THE INDUSTRY IN REVIEW

News

✦ Exports of electrical equipment for the month of March were valued at $12,587,564 compared with $10,919,912 for February and $12,971,734 for March 1940, according to the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C. First quarter 1941 shipments to foreign markets were valued at $36,507,516, increases of 6.4 and 48.0 per cent compared with the corresponding totals of 1940 and 1939 of $34,321,681 and $24,672,867, respectively. Radio apparatus sold abroad in March was valued at $2,431,183 compared with $1,705,597 for the previous month, an increase of 42.5 per cent. Radio receiving sets sold to foreign customers in March 1941 were valued at $1,106,586, an increase of 32.8 per cent from the February figures of $833,248. Exports of transmitting sets, tubes and parts were recorded at $493,652 in March 1941, one of the heaviest months in recent years, and an increase of 25.9 per cent from the February total of $392,147. Telephone and telegraph apparatus, with parts for same, were valued at $401,086 in March compared with $369,417 in February, an increase of 8.6 per cent.

✦ The 50-kilowatt frequency modulation station at Paxton, Mass. (owned by Yankee Network of Boston), formerly having the call letters of W1XOJ will now be known as W43B . . . Effective as of May 15th, station WING, Dayton, Ohio, has become a Basic Blue outlet of the Blue Network of the National Broadcasting Company. WING has been a Basic Red and Blue supplementary outlet.

✦ The General Electric Company suspended its 18-year old employees Savings Plan and put into effect a Defense Savings Plan to encourage its 105,000 employees to purchase United States Savings Bonds. Under the new plan all G-E employees may authorize the company to make deductions from their earnings for the purchase of bonds on a weekly, semi-monthly, or monthly installment payment basis . . . E. J. Thomas has been appointed engineer of the specialty transformer department and R. H. Chadwick has become assistant to the manager in charge of engineering at General Electric Company's Fort Wayne Works.

✦ Walter L. Brown of Huntington, W. Va., took office as vice-president and general counsel of the Western Electric Company, according to an announcement by C. G. Stoll, Company president. He succeeds T. Brooke Price, who becomes general attorney of the American Telephone and Telegraph Company. Mr. Brown, who was elected to Western Electric's board of directors a few weeks ago, also succeeds Mr. Price as general counsel for Electrical Research Products, Inc., and other Western Electric Subsidiaries . . . T. E. Shea, engineering vice-president of Electrical Research Products, Inc., has been granted an indefinite leave of absence to participate in important studies for the National Defense Research Committee. Dr. E. M. Honan of the Hollywood office will direct the motion picture engineering activities during Mr. Shea's absence.

✦ A radio log book which lists the newly assigned frequencies of all domestic stations and contains nontechnical information for short-wave enthusiasts has been prepared by the RCA Manufacturing Company. The book is being released through RCA Tube and Equipment Distributors throughout the country. This 32-page book includes the latest frequency modulation and television assignments, and serves as a guide to all standard United States and Canada broadcasting stations.

✦ Over thirty members of the Chicago Chapter of the Veteran Wireless Operators Association attended a dinner at the Lake Shore Athletic Club in that city to discuss their part in national defense and to further the progress of the Chapter. The retiring chairman, George I. Martin of R. C. A. Institute, presented a life membership

PLEXIGLAS FOR X-RAY TRANSFORMERS

Plexiglas windows are used in new Westinghouse x-ray transformers. Through these small windows engineers can observe the operation of the four rectifier tubes immersed in oil and located under the cover of the transformer. If any of the four rectifiers or valve tubes are burned out or if other abnormal operating conditions in them occur, these can be easily checked by quick visual examination, for the Plexiglas permits the operator to see into the heart of the transformer. Plexiglas is unaffected by oil, and resists breakage in service. The plastic is cut to size with wood saws and cemented into position in a simple sturdy oil-proof mounting. Plexiglas is available from the Roehm and Haas Company, 222 West Washington Square, Philadelphia, Pa.

to the new chairman, W. J. Halligan President of The Hallicrafters company. Plans were formulated for future meetings to be held at regular intervals.

Literature

Multivibrators. The theory and operations of multivibrators is discussed in the *Research Worker* available from Aerovox Corp., New Bedford, Mass. Three diagrams and a chart of grid resistance in ohms are also included.

Remote Controls and Kits. Crowe Name Plate & Manufacturing Company, 3701 Ravenswood Avenue, Chicago, have issued Bulletin 237 covering remote controls and kits for automobile radios. The various kits and controls may be used in connection with most auto radio sets.

Plastic Tone Arms. *Plastics News*, a house organ available from Durez Plastics & Chemicals, Inc., 122 Walck Road, North Tonawanda, N. Y., contains an article in the March 1941 issue on plastic tone arms made of Durez.

Antenna Manual. Arthur H. Lynch, member of Veteran Wireless Operators Association, and charter member of the Institute of Radio Engineers and the Radio Club of America, is the editor of the 1941 edition (No. H-4) of "Antenna Manual" which sells for twenty-five cents and is available from Premax Products, Division of Chisholm-Ryder Company, 41-R Highland Avenue, Niagara Falls, N. Y. The manual is intended as a complete and authoritative treatment of antenna design, construction and use for amateur, public and commercial service. Subjects covered in the book include rotary beams, vertical radiators, frequency modulation antennas, marine antennas, vertical beams, extended double zepp, commercial antennas, police antennas and a story of the antennas used at W2USA (New York World's Fair).

Resistor and Control Data. New and revised engineering data sheets are available to engineers, designers and manufacturers from Clarostat Manufacturing Company, Inc., 285 North 6th Street, Brooklyn, N. Y. These data sheets provide concise information on a variety of resistors, controls and resistance devices.

Receiver and Receiver-Transmitter. A four-page bulletin available from Air Associates, Inc., Bendix, N. J., contains illustrations and a description of type BR-3 receivers and type BR3-T receiver-transmitters for airplanes. Also included is installation specifications for the Series DR-3 radio system.

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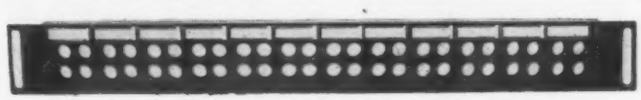

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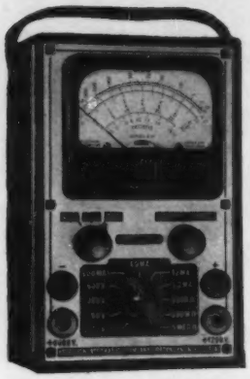

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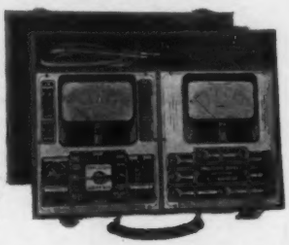

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Permanent Magnet Manual. Available from The Indiana Steel Product Company, Valparaiso, Ind., is Permanent Magnet Manual (No. 2) which covers permanent magnet applications in radio and sound equipment, generators and motors and control equipment.

Dial and Jewel Pilot Light Assemblies. Dial and jewel pilot light assemblies and parts are illustrated and described in a catalog available from Drake Manufacturing Company, 1713 West Hubbard Street, Chicago. Also included is information on required voltage and lamps; jewel colors; type of mounting; complete measurements; and a price list for each type of assembly as well as for individual parts.

Government Bulletin. "Farming Out Methods" is the fifth of a series of bulletins prepared by the Labor Division of the Office of Production Management, Washington, D. C. The series is designed to speed up defense production by describing practical methods by which idle machinery and idle skilled workers may be brought together, in cooperation with the program carried out by the Defense Contract Service. The new bulletin contains information for Government purchasing agents, prime contractors, sub-contractors, etc.

Frequency Modulation Permit List. An up-to-date list of all frequency modulation construction permits issued, as well as applications still pending, has been prepared by FM Broadcasters, Inc., 52 Vanderbilt Avenue, New York City.

Metco Metallizing Process. To describe the field of application where the Metco Metallizing Process can be advantageously used for rehabilitating worn shafts and other rotating machinery, as well as protecting metal surfaces against corrosion and other chemical attack, Metallizing Engineering Company, Inc., 21-07 41st Avenue, Long Island City, N. Y. has issued a new 16-page bulletin (No. 42) entitled "Metco Metallizing Equipment and the Metallizing Process." Also described is type 2E metal spraying gun and standard type E gun.

Recording Instruments. Improved alternating and direct current ammeters and voltmeters for general use are described in Catalog Section 43-414 available from Department 7-N-20 of Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa. Included are switchboard, portable, wall, and socket types. Special attention is given to application. Operation and construction details are explained.

Panelboards and Steel Products. A four-page bulletin available from Falstrom Company, Passaic, N. J. illustrates the various types of instrument panels available from them. Another four-page bulletin contains illustrations and descriptions of fabricated metal products made of either steel, alloy, copper, aluminum, brass, etc., for all industries.

Public Address Catalog. A new 48-page catalog devoted exclusively to sound equipment and including the new Lafayette line for 1941-2 has been issued by the Lafayette Radio Corp., 100 Sixth Avenue, New York City. Included in it are illustrated listings of some 25 amplifier models and approximately 75 completely coordinated sound systems, plus expanded lines of accessories, recorders, intercommunication equipment and custom-built systems for school, industrial and other specialized applications.

Selecting a Sound System. Allied Radio Corporation, 833 West Jackson Boulevard, Chicago, have available a new 1941 Spring and Summer catalog which is intended to help in the selection of public address equipment. An easy-to-understand chart covers equipment for churches, schools, auditoriums, outdoor meetings, etc. Information is given for computing the area to be covered in square feet, wattage required in the amplifier, size and make of speakers needed, and the type of baffle to use. An explanation of public address components is provided with each type of equipment being summarized for the most effective use.

New General Electric Bulletins. The following bulletins are available from General Electric Company, Schenectady, N. Y.

Bulletin GEA-3315B contains a list of radio transmitting tubes and new prices effective in March.

"How to Plan an F-M Station" (Bulletin GED-91) is a fifteen page reprint from the February, 1941 issue of F-M Magazine. It gives an outline of the requirement and cost of installing and operating a frequency-modulation broadcast studio and 1,000-watt transmitter.

Bulletin GEA-3571 describes the G-E plugging control system. It tells what makes up the plugging control equipment (type CR2962) and illustrates and describes the plugging switch. The last page of the bulletin is devoted to eight different ways of applying the plugging switch.

Multiple-operation arc-welder systems for manual or machine welding with metallic or carbon electrodes is described in Bulletin GEA 569F. Ratings, dimensions and weights are included.

The subject of Selsyns (a G-E trademark for self-synchronous apparatus) for remote signaling, control and indication is treated in bulletin GEA-2176.

"More For Your Control Dollar" (Bulletin GES-2456) is a booklet which contains success stories on control for important motors.

General Catalog. Trumbullist is a general catalog available from Trumbull Electric Manufacturing Company, Plainville, Conn. It contains complete descriptive information, details of construction and application and general dimensional data on electrical control equipment manufactured by Trumbull.

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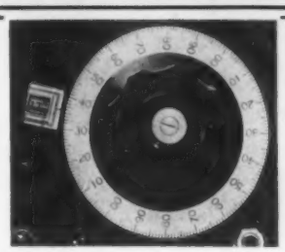

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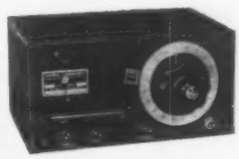

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PUSH-PULL VIBRATORS, available from The Turner Company, Cedar Rapids, Iowa, employ new engineering advancements designed to give smoother operation and longer life. The usual stock assembly has been eliminated. A continuous metal frame gives a dual magnetic path. The magnet or driving coils are nearly twice as large as in ordinary units and give greater driving force. When the air gap between the points is increased from two to ten thousandths of an inch the vibrators will continue to start and operate satisfactorily until all of the tungsten is worn off the points. A vibrator manual is available from the manufacturer.

Lightweight Mobile Amplifier

THORDARSON ELECTRIC Manufacturing Company, 500 West Huron Street, Chicago, Illinois, have available a 20-pound, 12-watt mobile amplifier which operates from a 6-volt storage battery and which was designed to simplify public address problems. The unit measures 13½x7½x7¼ inches. Several output impedances are available by adjusting a simple rotary switch selector, and a standby switch is provided which allows instant operation, when the switch is turned on, without waiting for the tubes to heat up. Extra heavy battery cables are supplied with clips for easy connection to the battery. The unit may be used with either a 6-volt or spring wound phono motor and turntable for record reproduction. Distortion is less than 5 per cent. Although the unit was designed for police cars, fire fighting equipment and sound trucks, it may also be used on military drilling fields, athletic fields and parade grounds.

Four-Pole Relay

A FOUR-POLE DOUBLE-THROW relay is the newest addition to the line of type "C" relays manufactured by the G-M Laboratories, Chicago. One of the features of G-M type "C" relays is precise machine assembly of parts, which makes for economical quantity production. Self cleaning wiping action of the contacts and long electrical and mechanical life are other features. Operating voltages under normal conditions range from 2 to 230 volts alternating current and 2 to 125 volts direct current. Normal contact capacity is 10 amperes on non-inductive alternating current loads but special contact materials for specific applications may permit the control of considerably higher current. Overall dimensions of the four-pole relay are 2 9/16 inches long, 2⅛ inches high, and 2⅜ inches wide for normal application.

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A precision frequency standard capable of being adjusted to WWV or some other primary standard and putting out uniformly accurate calibrating signals with 10, 25, 100, 1000 KC intervals. Uses the new GENERAL ELECTRIC No. 18A 1000 KC crystal having a frequency temperature coefficient of less than one cycle /Mc/C°. The crystal is sealed in Helium in a standard metal tube envelope.

The self-contained AC power supply has VR150-30 voltage regulator tube.

In addition to oscillator, multivibrators, and harmonic amplifier, a built-in mixer with phone jack and gain control on panel is incorporated.

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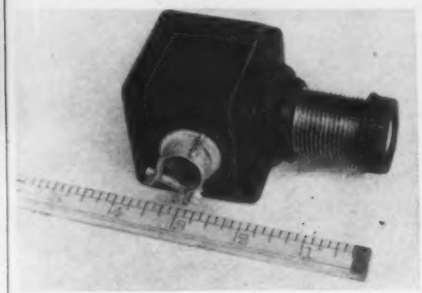
Light Source and Photocell Housing

GENERAL CONTROL COMPANY, Cambridge, Mass., announces type PR-3 light source and photocell housing, which is compact, rugged, splash-proof and easily installed and adjusted. A two-inch tube makes up the main body of the housing and an additional two-inch extension is provided for the lens tube which is optically grounded and



polished and has an aperture of $f/1$. A removable standard BX squeeze connector is provided. The unit may be mounted on a ½-inch pipe or conduit and accommodates the type 924 end-type phototube. Light is obtained from a 6-candlepower 6-8 volt lamp. With suitable accessory equipment the unit will operate over distances up to 30 feet or down to 2 inches from the lens.

Combination Antenna System

THE DEVELOPMENT OF a single combination antenna system for serving frequency modulation amplitude modulation, short-wave and television systems has been announced by Technical Appliance Corporation, 17 East 16th Street, New York City. Known as the Taco combination antenna system, it consists of selector transformers utilizing ultra-high frequency iron cores for maximum transfer of radio energy. The system starts with a dipole comprising two metal rods held by a center bracket mounted atop a mast. The two rods connect with the antenna transformer mounted on the mast, which transformer in turn feeds into the transmission line. Variations are available to suit any installation problem.

The transmission line may be of any length up to and exceeding 100 feet if required. The dipole can be placed high above the building for maximum signal pickup, while the transmission line and transformers cancel out noise pickup. For store demonstrations a special type transformer is used for each set, permitting as many as eight sets to be operated on the same system, simultaneously, without interference with each other and without detraction from individual performance in any category of reception. A polarization bracket holding

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Sensitivity (constant) 150 megohms on high ranges, 15 megohms on low ranges.
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Invaluable for measuring oscillator and amplifier grid voltages, AVC, AFC, limiter and discriminator grid voltages—while signal is present and without disturbing circuit constants.

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Input capacity only .00005. Accurate over exceptionally wide range of frequencies. 16meg. input. Indispensable for gain measurements, output measurements, etc.
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Clear, accurate readings from .1 ohm to 1000meg.
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No test leads to short. No zero resetting when changing ranges. No danger of shock when testing live resistors.

VACUUM TUBE CAPACITY METER
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Wide range measurements from .00003 to 10 0mfd.
Ranges: 0/.001/.01/.1/1/10/100/1000.
No danger of shock on low capacity ranges. No leads to short. No zero reset when changing ranges.

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950—Radio push-back wire
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1702—Aircraft wire—Army and Navy—shielded
1714—Aircraft wire—Navy
1802—Flexible motor lead wire
1901—Asbestos lead wire and flexible cable
2002—Varnished cambric transformer and apparatus cable
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2500—Oil resisting machine tool control wire
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- Communication Equipment
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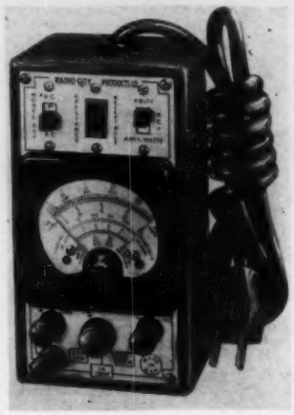
the dipole to the mast permits tilting the dipole at any angle from horizontal to vertical, for required polarization, as well as swinging the dipole flatwise to the desired transmitter. The mast is held to roof coping, pipe, water tank, wall or other available structure by means of brackets. At great distances from the transmitter or for locations where signal strength is extremely low, it is advisable to use a reflector comprising a second dipole supported a quarter wavelength behind and parallel to the first dipole, by means of a crosswise bracket.

Pocket Size Tester

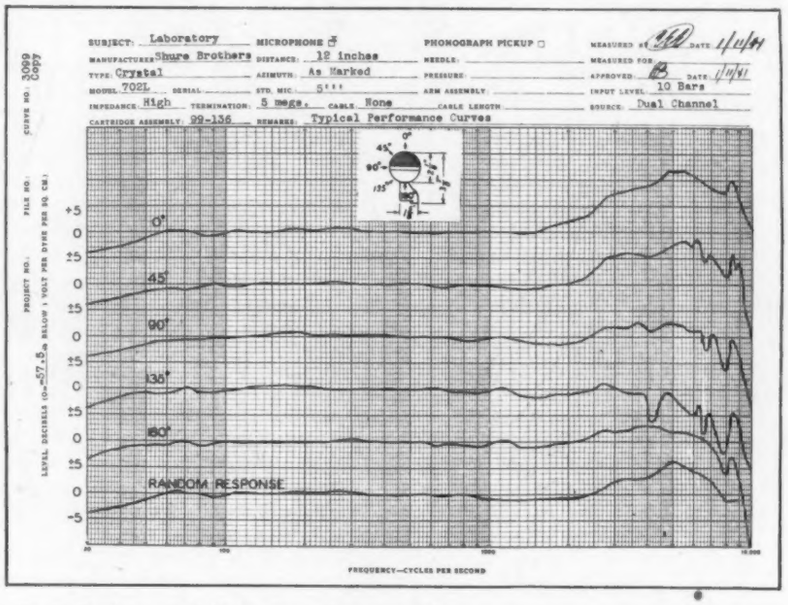
FOR SERVICEMEN AND SALESMEN of electrical appliances, as well as electrical contractors there is a new and inexpensive, pocket-size appliance tester introduced by Radio City Products Co., 88 Park Place, New York City. The Model 417 appliance tester speeds up testing, trouble diagnosis and power-consumption demonstrations by elimination of connection terminals. It is only necessary to plug the tester into the line and the appliance, in turn, into a receptacle provided on the face of the tester. Two 2-position toggle switches and a 3-position rotary switch then permit instant selection of the type of measurement and the meter range desired, with all measurements of voltage, current and power consumption provided by the multi-scale, alternating or direct current meters. Heavy duty terminals are provided for current values in excess of appliance ratings.

Measurement ranges provided include alternating current and direct current line voltage up to 250; four direct and alternating current ranges to 25 amperes; four direct and alternating current power ranges to 3000 watts. Power ranges are direct reading where the line supply is 120 volts



and power factor of the appliance is unity. Curves and data supplied with the instrument permit rapid conversion for different values of voltage and power factor. The unit also permits direct comparison of power consumed by various appliances, as well as making power measurements of motors up to several horsepower. Overall dimensions of this instrument are 5¼ inches long, 3¼ inches wide and 2 inches deep.

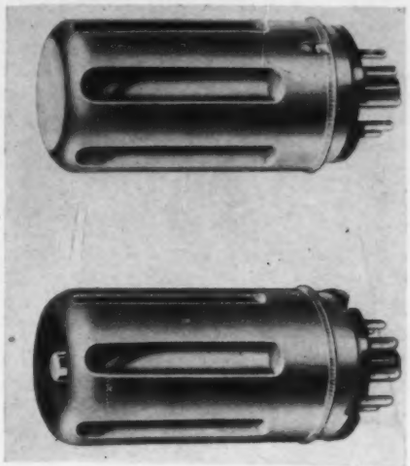
LABORATORY MICROPHONE



Shure Brothers, 225 West Huron Street, Chicago, announce a new crystal type laboratory microphone, known as model 702L, which is designed for measurement work. Typical performance curves are shown. They were measured 12 inches from the speaker at an input level of ten bars. These microphones are available with an individually calibrated curve at an extra charge

Tube Shields

GOAT METAL STAMPINGS, Inc. (formerly Goat Radio Tube Parts, Inc.) announces a new "1330 Series" tube shields for GT/G, GT and Loktal tubes. Made of one piece, the new Goat Form-Fit tube shield is solid drawn (with an attractive ribbed design) and fits the tube snugly and positively. Efficient shielding is assured. The



shields are quickly and easily attached and are automatically grounded to the metal base of the tube. This eliminates any necessity of attaching any extra piece to the chassis.

Four types are available, and they are completely described in a bulletin which may be obtained upon request from the manufacturer located at 314 Dean Street, Brooklyn, New York.

Laboratory Condenser Bridge

THE TRIPLETT ELECTRICAL Instrument Company, Bluffton, Ohio, announces a laboratory condenser bridge known as model 1640 which checks the capacity, at 60 cycles per second, of all condensers (paper, electrolytic or mica) from 0.00025 to 250 microfarads. It provides conclusive tests for shorts, opens, leakage and breakdown. Incorporated in the tester are two three-

inch Red Dot instruments, one of which has a good-bad scale for leakage of electrolytics rated from 2 to 250 microfarads, based on 0.2 milliamperes per microfarad, at rated voltage. Direct readings in milliamperes may be made. For condenser leakage measurements the voltmeter and milliammeter are in the circuit at the same time.

NEW TRANSMISSION MEASURING SET

The Type 6C Measuring Set provides an accurate and rapid method for measuring the transmission characteristics of networks at audio frequencies.

This new set has the following outstanding features which contribute to its usefulness in the radio broadcasting field.

★ REFERENCE LEVEL: New standard of 1 mw. in 600 ohms.
★ METERS: New Type 30 standards.
★ ATTENUATION RANGE: Zero to 110 db. in steps of 1 db.
★ POWER RANGE: Calibrated from —16 to +45 db.
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★ IMPEDANCES: Dial selection of useful network input and load impedances.
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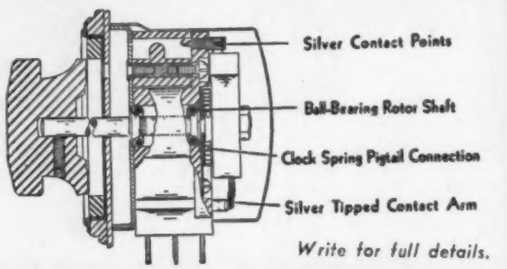

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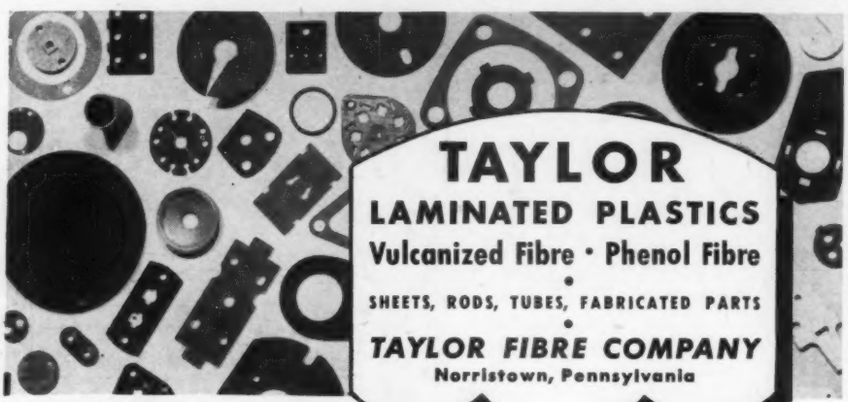

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Kilovoltmeter Multiplier

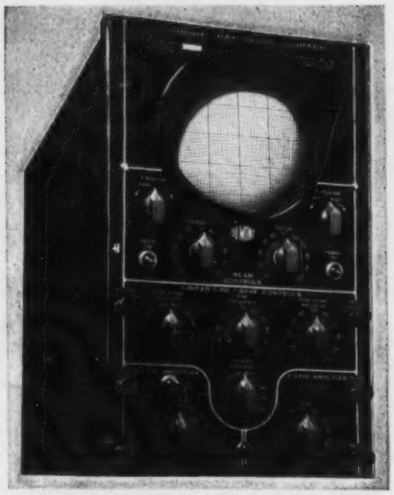
THE NEW 765 KILOVOLTMETER multipliers are resistance boxes designed by Shallcross Manufacturing Company, Collingdale, Pa., to furnish a practical and inexpensive external meter multiplier for a variety of instruments for measuring potentials. This instrument consists of a low potential voltmeter connected with a high resistance known as the multiplier, which permits connections across a high potential line for making voltage measurements. There is good distribution of voltage from the safety standpoint and the resistance multiplier is not affected by humidity. It is a compact unit which can be made portable or can be permanently installed, and will operate on either alternating or direct current.

Plug Switches

A. W. FRANKLIN MANUFACTURING Corporation, 175 Varick Street, New York City, announces a new line of plug switches of the socket receptacle type. This is an addition to a varied line of radio and electrical components. The switch illustrated utilizes spring and insulator arrangement to form a single pole, double throw on the other section. These can be varied to produce other electrical requirements. Special attention to the design has produced a favorable "insertion to extraction" ratio particularly desirable in midget models of radio receivers. Contacts are of spring phosphor bronze and are silver plated for low resistance electrical contacts. The mounting is of low loss General Electric Textolite. The switches are actuated by a standard line plug or special round pin plugs.

Glass Base Recording Blanks

AUDIO DEVICES, 1600 Broadway, New York City, announce the development of glass base recording blanks to replace aluminum discs. By a new technique used in cutting and drilling the glass, the manufacturer has produced a disc on which recorded sound is reproduced perhaps a little better than on standard aluminum blanks. A double face coating is used to reinforce the base for shipping purposes.



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★ Replete with features that make your work easier and more pleasant, DuMont Type 208 Cathode-Ray Oscillograph will extend your investigations into studies not previously feasible without much labor and expense. That is why it has already won the highest endorsements of users since its introduction a year ago.

This oscillograph is but one of a large line of instruments, cathode-ray tubes and associated equipment developed, produced and marketed by the DuMont organization in a decade of intensive specialization. Such proven achievements have won for DuMont the enviable title of "Cathode-Ray Headquarters."

Write for engineering data. Submit cathode-ray problems for engineering aid, recommendations, specifications, quotations.

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Resistor for Fluorescent Lamps

RESISTORS OF SMALL SIZE with low temperature rise for d-c operation of fluorescent lamps are now available in a complete line of voltages and resistances and sizes to fit all standard wiring strips from International Resistance Co., 401 N. Broad St., Philadelphia, Pa. The resistance units are wire wound with molded 1250-volt insulation topped by a metal strip to aid in heat dissipation. The temperature rise is approximately 40 to 50 degrees C. with standard auxiliaries. Overall dimensions are approximately 6¾ by 1¾ x 1¼ inches and the total weight is less than 12 ounces.

Amateur Communications Receiver

MODEL EC-1 COMMUNICATIONS receiver was designed for amateurs and others wishing to learn the code. Known as the Echophone Commercial, the receiver provides for reception of both phone and code on a range of 545 kilocycles to 30.5 megacycles, and has self-contained facilities for keying and code-reading practice. The instrument is available from Echophone Radio Corporation, 201 East 26th Street, Chicago. With a standard telegraph key connected in series with the headphone, the output of the receiver to the headphone will be broken up into dots and dashes as the circuit is keyed. If the receiver is tuned to a broadcast or other steady carrier, and its beat-frequency oscillator turned on, this output will be in the form of a heterodyne whistle. When keyed the result is an imitation of the sound of regular radio telegraph transmissions. Group copying practice is possible if the headphones are placed on the table and the receiver volume turned up to make their sound audible over a

reasonable range. By connecting two keys in parallel it is possible to carry on two-way communication with either participant breaking in at will. When some degree of speed has been achieved in code copying then the regular code transmissions of commercial stations can be tuned in for actual on-the-air practice. The headphone circuit of this receiver is completely isolated from the line and high voltage supplied by an output transformer, and thus the possibility of shock while handling the key is completely avoided.

1921

MILESTONES

★ Recognize the above gadget? Of course you do, if you're a real oldtimer. This was the Clarostat compression-type control used in tricky regenerative receivers and later in B-battery eliminators for controlling output voltages. Even then, as now, Clarostat pioneered in controls and resistors.

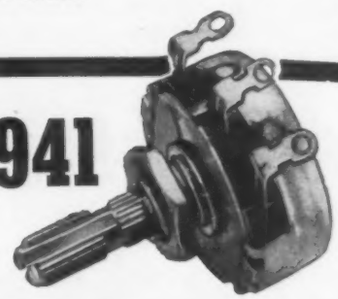
Twenty years have passed since that cumbersome compression-type Clarostat. During that time the Clarostat organization has developed, designed and produced millions of controls — compression, wire-wound, composition-element. Likewise every kind of resistor. The present midget control, shown below, reflects a pioneering experience second to none in the industry.

Indeed, you'll never know how good a control can be until you've tried today's Clarostat. Likewise with all types of resistors made by Clarostat, either standard or special. You owe it to yourself, to your trade and to your public, to try Clarostat products.

Write for DATA . . .

Loose-leaf engineering data on all types of controls and resistors, sent on request to designers, engineers and manufacturers of radio and electronic equipment writing in on business letterhead. Your control and resistance problems are invited.

1941



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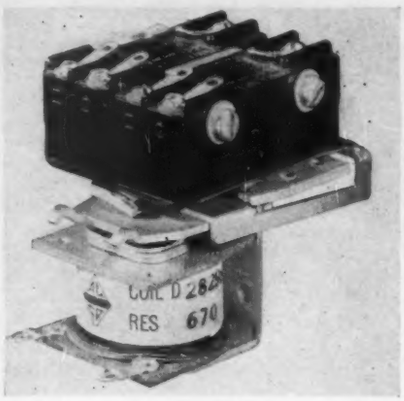
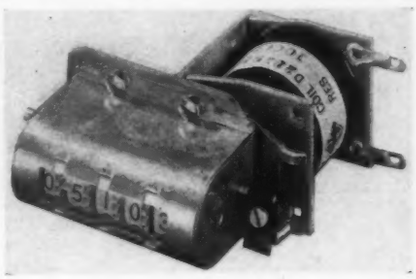
Microswitch Relay and Accessory

MADE TO MEET A DEMAND for an inexpensive relay having electrical contacts with larger current carrying capacity is an Autelco Jr., microswitch relay available from Automatic Electric Company, 1033 West Van Buren Street, Chicago. The unit is sensitive, with easy-acting contacts designed for handling loads up to 10 amperes (alternating current only) with small con-



trolling currents. These relays are especially useful for locations subject to sudden jarring, vibration, or tilting. The relays are furnished with one or two microswitches, each with make, break or break-make contacts. They can also be supplied with one break-make microswitch and one break-make spring assembly with code No. 2, No. 4, or laminated silver contacts. The maximum operating voltage is 240 volts, direct current or 50–60 cycles per second alternating current.

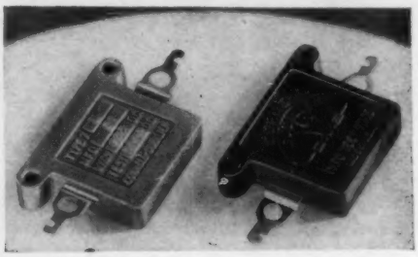
Recently introduced by Automatic Electric Company, is a new inexpensive electrical counter as a companion piece to its line of Autelco Jr. relays. This new counter is known as the Autelco Jr. counter and is built for high speed alternating or direct current operation.



It is adapted to general industrial use, coin operated devices, etc., and is of the non-reset type. It counts up to 99,-999 and then repeats. The maximum operating voltage is 240 volts, direct current or 50–60 cycle alternating current. For alternating current operation, maximum speed is 15 steps per second; for direct current operation, maximum speed is 20 steps per second.

Bakelite Mica Capacitors

A NEW ADDITION to the Cornell-Dubilier line of Mica dielectric capacitors is the Type 7 illustrated. This is a moulded bakelite capacitor, similar to the existing Type 4, but with wider spacing between the insulated mounting holes to meet the 1¼-inch standard. Standard units are moulded in brown bakelite and are available in capacities beginning at 0.00005 microfarad and running up to 0.03 for



those rated at 600 volts (direct current working), 0.01 for the 1200-volt rating, and 0.003 for the 2500-volt rating. Standard tolerance in capacity ratings is plus or minus 10 per cent. Insulation resistance is 20,000 megohms. Each unit is clearly stamped with the capacity value, direct current working voltage and direct current test voltage.

The capacitors can be supplied moulded in low-loss bakelite (insulation resistance 40,000 megohms), with salt-water immersion seal against humidity; or temperature aged for stabilizing capacity over extremely wide temperature changes.

Reflex Projector

ATLAS SOUND CORPORATION, 1443 39th Street, Brooklyn, N. Y., announce a new intermediate 4½ foot Morning Glory reflexed projector Model DR-54, which has a bell opening of 25 inches. The effective air column is 54 inches. The dynamic reflex design reduces the overall length of the double re-entrant trumpet to 23½ inches. This new size

projector is good for general public address application, such as sound truck use, where the overall length must be considered but where sufficient air column length is required for good reproduction of voice as well as music. An adjustable mounting bracket is supplied with the unit.

Three-Band Radio Receiver

A TWO-UNIT MIDGET radio receiver for aircraft, that also serves as an interphone, has been announced by the Western Electric Company, 195 Broadway, New York City. It may be tuned continuously or operated as a crystal controlled unit on two "spot" frequencies. The new instrument, known as the 33-A radio receiver, has all the controls mounted on a radio frequency unit which fits directly through the instrument panel within arm's length. Including its separate power conversion apparatus (which may be installed in any convenient place) the apparatus weighs 18 pounds 7 ounces complete with crystal equipment. Its mounting space in the instrument panel is 7⅝ inches by 6 inches.

The interphone feature is interesting. By lowering the volume of the incoming radio signal, flight personnel may converse freely and simultaneously monitor the incoming messages. When, however, the volume is increased to a satisfactory listening level for the signals, it is still possible by loud talking to override the signals if the necessity arises. The power unit, which draws 1.5 amperes, is operated directly from a 24-volt battery supply, although provision for 12 volts may be made optionally. Other performance characteristics of the new receiver include high audio output—700 milliwatts; wide frequency coverage—350 to 625, 3900 to 7500, and 6750 to 12,200 kilocycles; average sensitivity is 5 microvolts for an output of 50 milliwatts. The new unit will receive both phone and CW telegraph signals. A write-in type dial plate has been provided so that crystal spot frequencies may be conveniently identified.

Loudspeaker Driver Unit

THE MODEL MD8 LOUDSPEAKER DRIVER unit is the smallest driver unit produced by the University Laboratories, 195 Chrystie Street, New York City. It is efficient, and has uniform frequency response. This driver may be

used on any of the exponential reflex horns in a similar manner to the previous types of driver units made by University Laboratories. It is waterproofed by a special spun aluminum shell and a sealed diaphragm construction. The power handling capacity is 12 watts, and impedance is 8 ohms.

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TYPE 150-A

Here is a signal generator developed specifically for use in the design of FM equipment. Built into it are the features requested by FM engineers. Both Frequency and Amplitude Modulation available separately or simultaneously. All controls direct reading. Expanded scale meters. Power line regulation optional.

Brief Specifications

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Deviation from zero to 200 KC
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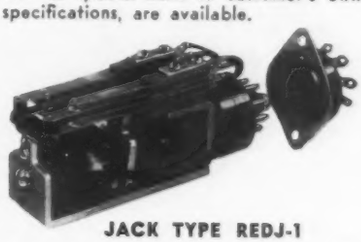

JACK TYPE REDJ-1

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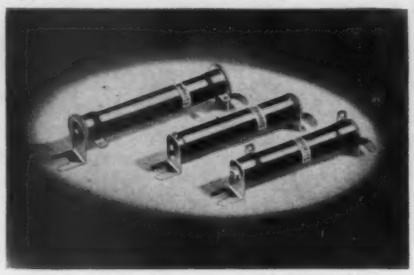
in solving your most difficult problems in the specialized field of electronic devices is offered by consultants whose cards appear on this page.

Resistors

WIRE-WOUND vitreous-enameled resistors are available in "live" bracket and "dead" bracket types for special applications from Ohmite Manufacturing Co., Department 10, 4835 Flournoy Street, Chicago, Ill. The live bracket type resistors have flexible leads connected to tin-plated brass brackets. They are designed for mounting and making electrical connection by bolting the slotted brackets to panel terminals. Ohmite dead bracket type resistors are mounted by bolting to the brackets.



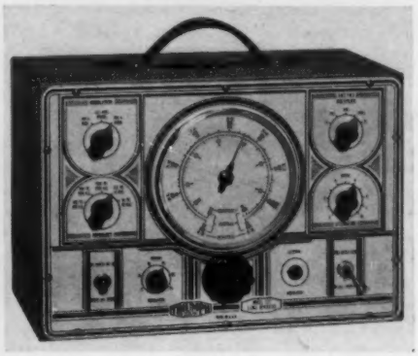
Electrical connections are made separately to the lugs. The brackets for one, two or three resistors are mounted to the resistors by means of through-bolts. The leakage distance from lug to bracket can be regulated by the use of mica washers or by having the lugs located as far in as required. Both types of resistors are used for signal circuits, electrical refrigeration controls, storage battery charging, switchboards, and other applications. They are available in a wide range of core sizes with diameters from $\frac{5}{16}$ inch to $2\frac{1}{2}$ inches.

Ratchet Relay

TYPE CX2600, a new ratchet relay recently announced by Struthers Dunn, Inc., 1335 Cherry St., Philadelphia, Pa., combines small physical size with good performance in opening and closing an electrical circuit over a single line. The new relay has two independent poles and, by factory adjustment of its cams, may be made single pole, double break, single throw; double pole, single break, single throw; or single pole, single break, double throw. Units are available for both intermittent and continuous duty. Base size is 3–13/16x2 inches, the relay being designed for front-connected vertical mounting. Contact rating for non-inductive load is 110 volts, 6 amperes, or 220 volts, 3 amperes alternating current; or 115 volts, 1 ampere, direct current. Coils are available from 6 to 220 a-c volts, at approximately 4 watts; or 2 to 230 d-c volts, at approximately 2 watts. Direct current voltages above 90 require a series resistor in the coil circuit. A catalog is available.

Signal Generator

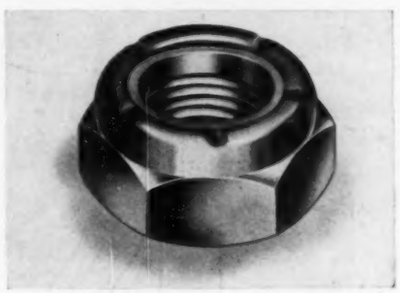
MODEL 131 SIGNAL GENERATOR, (available from Triumph Manufacturing Company, 4017 West Lake Street, Chicago,) has a large dual-scale dial, calibrated to one-half of one per cent from 100 kilocycles to 96 megacycles. The signal generator unit allows sensitivity, selectivity, automatic frequency control, automatic volume control, and



overload tests of receivers. The instrument is also capable of giving variable percentage modulation at 400 cycles per second, or any other audio frequency. The size of the unit is 13 x 9 x 7 inches, and it is available in various colors including ivory, green, and black panel on brown wrinkle case.

Thin Hex Nuts

FOR USE ON SHEAR bolts where a high degree of the stress is lateral, and for general application to light and medium stress fastenings, an improved line of thin hex nuts is announced by Elastic Stop Nut Corporation, 2332 Vauxhall Road, Union, New Jersey. These nuts have approximately 40 per cent of the strength of standard height hex nuts and have been approved for weight by civil and military authorities. As in the standard-height Elastic Stop Nuts, the self-locking action is accomplished by means of a vulcanized fiber collar



which is built into the head of the nut. This bone-like material resists the entry of the bolt, and forces the nut outward and to take up all thread play. The fiber, (non-metallic and of a resilient character), does not deteriorate under vibration. The nuts are available in steel, brass, and aluminum, in a complete range of standard sizes, both coarse and fine thread. A folder available from the manufacturer explains in detail the Elastic Stop self-locking principle.

CONTACTS

FOR THE FIELD OF ELECTRONICS

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COLLEGE GLASS working units for students and laboratory

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which work on the principle of vibration isolation by bonded rubber in shear.

Suspended weight can be from Ounces to Tons

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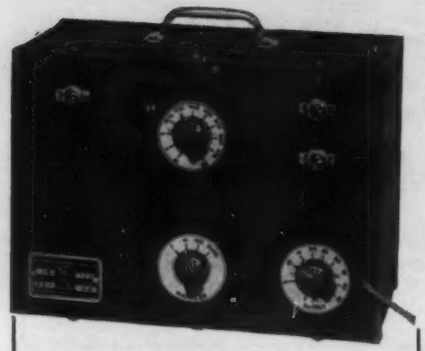
Electronics

330 W. 42d St., New York, N. Y. ?



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* Variable air condenser for each frequency
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Additional information on this and other Signal Generators on request.

Monarch MANUFACTURING CO.
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Where SECONDS Count, Use *Industrial's* Automatic Time Controls

In national defense and industrial production, seconds can spell success or failure.

Production *steps* UP with *Industrial's* timers on the job—offering complete, accurate control.

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103 Edison Pl., Newark, N. J.

Automatic Direction Finder

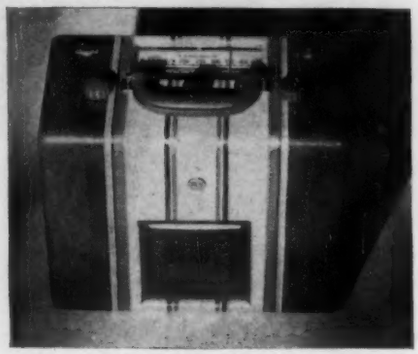
THE ENTIRE FLEET of Douglas airliners on the 600-mile route of Pan American-Grace Airways is now being equipped with Learadio ADF-8 automatic direction finders, it was announced by Lear Avia, Inc., 30 Rockefeller Plaza, manufacturers of aircraft radio and accessories. Each ship is equipped with a complete ADF-8 direction finder, comprised of an automatic station-seeking direction finding loop with "Fastop" electromagnetic clutch mounted underneath the fuselage; a five-band ADF-8 reeciver remotely controlled from the radioman's post; and two 360-degree azimuth

indicators: one located in front of the pilot, the other in front of the radioman. A second five-band ADF-8 receiver unit only, complete with remote control, is also installed at the radioman's post. A special selector switch enables the radioman to use either receiver unit for either direction finding or communications reception. In normal operations, one ADF-8 unit is constantly in use for directional guidance, while the other remains free for communications work. When it is necessary to obtain precision cross bearings, the two receivers may be tuned to two radio transmitting stations, and almost instantaneous cross bearings obtained by connecting the two receivers alternately to the azimuth indicator, thus eliminating tuning delays.

Each ADF-8 receiver unit is a superheterodyne covering the frequency range from 195 to 15,360 kilocycles in five bands: 195–405, 498–1195, 1190–2832, 2800–6720, and 6400–15,360 kilocycles. The first three bands of each receiver are arranged for both direction finding and communications reception; the last two bands are arranged for communications reception only.

Three-Way Aviation Portable Radio

AVAILABLE FROM RCA Manufacturing Company, Camden, New Jersey, is a portable radio receiver which receives such important aviation information as CAA weather reports, radio range courses, and airport control tower signals, as well as standard broadcast programs. Designated as Model AVR-102, the new receiver is housed in a two tone airplane fabric covered case, and is equipped for three-way operation, on self-contained dry batteries, in a plane, or from alternating current or direct current electric outlet at home, in hotels, etc. The list price is $39.95, less batteries. The unit has a six-tube, two-band superheterodyne



chassis, equipped with a built-in static-limiter switch to bring in weak signals above stormy noise levels and to reduce possible engine interference. Other features are a tuned radio frequency stage, high sensitivity, and three-gang condenser to provide freedom from adjacent station interference, rubber mounted chassis to withstand shock and vibration, and built-in loop antenna. The AVR-102 is ready for operation when connected to a ship antenna and used in a plane. A jack is provided for headphones, and the dry batteries are rated at approximately 200 hours of operation. A simultaneous radio range filter, available at extra cost, permits clearer reception of weather broadcasts and other voice transmissions without interference from the radio range signals upon which the voice transmissions are superimposed.

Photoelectric Relay

THE UNITED CINEPHONE Corporation of Torrington, Connecticut, announces the "Sun-Switch," a new photoelectric relay for lighting and power which is primarily designed as an aid to greater safety and economy in incandescent lighting applications. The unit is used to control electrical circuits in accordance with the rise and fall of natural illumination. The user chooses the two lighting levels at which he wishes the load switched on and off, and then adjusts the calibrated dials to the corresponding footcandle readings. Operation is entirely automatic, no resetting is necessary. The control circuit uses a type 921 phototube, and two type 6J5 tubes. Operation is from 110 volts, 50 or 60 cycle per second alternating current. The manufacturers list the following applications in which the relay may be effectively used: Aircraft beacons, airport lights, street and highway illumination, billboards and spectacular type signs, department store lighting, indoor and outdoor factory lighting, museums, hospitals, etc.

ZERO CENTER
VACUUM TUBE VOLTMETER

Million does it again! ★ Tests 1000 megohms insulation center. ★ Tests oscillator grid bias while in operation at 3,333,333 ohms per volt. ★ With over 30 scales. Big, easy to read zero center meter. For standard and FM sets. Literature FREE!

Model J Net only **$29.95**

MILLION RADIO AND TEL.
1619 No. Damen • Chicago, Illinois

Automatic Checkup of Industrial Solutions

AN ELECTRONIC INSTRUMENT now available is designed to check the concentration of solutions and steam condensate. It warns of any excess, or automatically sets the corrective means to work. Known as the Solu-Bridge Controller, offered by Industrial Instruments, Inc., 156 Culver Avenue, Jersey City, N. J., this instrument combines the analytical function of the Solu-Bridge, with a sensitive vacuum-tube relay to control an external circuit (alarm or an electromagnetic valve). The instrument is based on the conductivity of the solution or condensate being checked. A cell placed in the liquid makes electrical contact with a sample of definite cross section and length. The electrical conductivity of the sample is measured by a Wheatstone bridge utilizing the "magic eye" as the balance indicator.

The controller can be remotely connected with the one or more conductivity cells. The front panel features a small dial which is set for the approximate temperature of the solution or condensate, while a large main dial is rotated for the analytical and controlling functions. Observing the magic eye through the hooded peephole, when the indicator presents the widest angle of dark segment, the reading, is taken directly off the main dial.

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Proposals, 50 cents a line an insertion.

INFORMATION:

Box Numbers in care of our New York, Chicago or San Francisco offices count 10 words additional in undisplayed ads.

Discount of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals).

DISPLAYED—RATE PER INCH:

The advertising rate is $6.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An advertising inch is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. E.

NEW ADVERTISEMENTS received by 10 A. M. June 27th will appear in the July issue, subject to limitations of space available.

POSITION VACANT

LARGE MIDWESTERN radio receiver manufacturer has openings for experienced automotive and household radio receiver design engineers. Applicants should state education, experience and give references. Our own employees know of this ad. P-270, Electronics, 520 N. Michigan Ave., Chicago, Ill.

SENIOR ENGINEER: Familiar with chassis layout and circuit design. At least 4 years experience in radio manufacturing necessary, executive desirable. Permanent position with long-established concern. Present staff know of this opening. For personal and confidential interview, apply P-283, Electronics, 330 W. 42nd St., New York, N. Y.

CHIEF DRAFTSMAN or Senior Draftsman: With radio experience to take charge of new drafting department. Permanent position. Present staff know of this opening. For personal and confidential interview, apply P-284, Electronics, 330 W. 42nd St., New York, N. Y.

JUNIOR ENGINEERS: Communications; radio. 3 college graduates with some experience or High School graduates with at least 3 years laboratory experience. Permanent positions. Present staff know of these openings. For personal and confidential interview, apply P-285, Electronics, 330 W. 42nd St., New York, N. Y.

POSITIONS WANTED

RADIO PATENT EXPERT and Electrical designer, proven merit. My designs have largest sales value of any advertised. R. G. Evans, 3945 Second, Detroit, Mich.

RESEARCH PHYSICIST (Ph.D. 1937), good math. background, proven initiative in tackling projects in electronics, r.f. and communication engineering and measuring equipment, intends to change position. Steady, long range development and research in applied electronics or allied fields desired. PW-282, Electronics, 520 N. Michigan Ave., Chicago, Ill.

Additional Electrical Line

Wanted by newly established manufacturers' representative which can be sold to manufacturers or Utilities for Connecticut or New England. Sixteen years' experience in the electrical industry. Write

Box 1393,
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Used
ELECTRONIC TUBE EQUIPMENT
Complete line of used equipment for the manufacture of Radio Tubes, Neon Tubes, Incandescent Lamps, etc. Write for Bulletin showing 25 to 75% savings.
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formerly Eisler Electric Corp.
534 39th Street, Union City, N. J.

HIGH GRADE USED
ELECTRON TUBE MACHINERY
Huge Stock of Every Type and Variety
KAHLE ENGINEERING CORPORATION
Specialists in Equipment for the manufacture of Neon Tubes, Radio Tubes, Incandescent Lamps, Photo Cells, X-ray Tubes, etc.
900 DeMott St., North Bergen, N. J.

FILMGRAPH
Sound-on-Film RECORDER and REPRODUCER *(Patented)*
New 1942 line NOW READY. Bargain prices on small remaining stock of 1941 models, for close-out. Cost of recording 12½c per hour. Lengthy recordings—may be indexed for easy reference.
MILES REPRODUCER CO., INC.
Dept. EL. 812 Broadway, New York

RA-281 Sound Frequency Analyzer will locate it . . .

The RA-281 Recording Sound Frequency Analyzer is adaptable to almost every noise or vibration testing problem. You may use it as a standard high-precision sound level meter or as a sound frequency analyzer—with either Western Electric moving coil mike or moving coil vibration pickup. It delivers data either on a graphic record or on an indicating meter.

You can count on the RA-281 for highest precision—it's calibrated to Bell Laboratories standards. Write for details—no obligation.

Electrical Research Products Inc.
76 Varick Street, New York, N. Y.
A Subsidiary of
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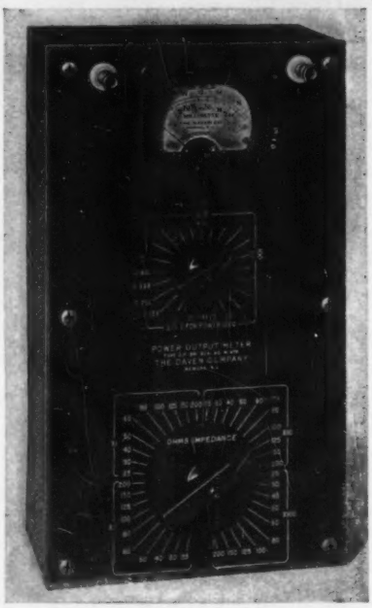
ACCURACY ±2%



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★ Provides direct reading of POWER or Db. LEVEL from 0.1 mw. to 50 watts.
★ Load impedance range 2.5 to 20,000 ohms; 40 steps.
★ Frequency range 30 to 10,000 cycles.
★ Accuracy ± 2% at midscale meter reading.

$110

Write for further details

* Patented

THE DAVEN COMPANY
158 SUMMIT STREET • NEWARK, NEW JERSEY

Power Resistor Decade Boxes

POWER RESISTANCE DECADE boxes are available from Clarostat Manufacturing Company, 287 North 6th Street, Brooklyn, N. Y., for use in laboratories, engineering offices, plants, maintenance departments and schools to solve practical resistance problems under actual working conditions. The boxes provide a precise power resistance of from 1 ohm to 999,000 ohms for actual use in a given circuit. Up to 225 watts per decade can be handled by adjusting any or all of the six rotary decade switches provided on the instruments. The reading for the inserted resistance is read from decade dials. The instruments will also determine parallel resistance values, voltage-dropping requirements, and has other practical functions.

Electroplating Rectifier

THE W. GREEN ELECTRIC COMPANY, 130 Cedar Street, New York City, have available model 7100T electroplating rectifier (built around a selenium rectifier) which is known as "Selectro-Plater" and which is rated at 1000 amperes six volts continuous operation. The safe overload capacity is 25 per cent. The unit weighs 750 pounds, occupies less than three square feet of floor space and can be mounted on caster wheels and shifted from point to point in a plating plant. Efficiency is

maintained at 65 per cent to 75 per cent from full load rating down to a fractional load. The main transformer and the voltage control transformer are insulated with fiberglass and mica. Other characteristics of the "Selectro-Plater" include no moving parts, instantaneous starting and noiseless operation, controls and indicating instruments located on the front panel, and simple wiring. "Selectro-Placers" are available to be used in conjunction with the original equipment if the need arises.

BUYERS' GUIDE . . . . . for the ELECTRONIC and ALLIED INDUSTRIES

Sources of materials, parts, components and supplies for engineering and manufacture of radio, communication, industrial applications of electronic circuits and feeble-current control.

IMPORTANT!

All products are listed under the noun or principal word — not under the adjective. THUS: — Paper Insulation will be found under INSULATION and not under Paper; Binding Posts under POSTS, not under Binding.

Adapters

TEST ADAPTERS

Alden Products Co., 715 Center St., Brockton, Mass.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
Million Radio & Television Labs., 685 W. Ohio St., Chicago, Ill.
Radio City Products Co., 88 Park Pl., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Triplett Electrical Instrument Corp., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Ammeters

CONTACT MAKING AMMETERS

Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

INDICATING AMMETERS

Bristol Co., Waterbury, Conn.
Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Columbia Electric Mfg. Co., 4519 Hamilton Ave., Cleveland, Ohio
De Jur-Amsco Corp., Shelton, Conn. (See Advertisement Page 117)
Engelhard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
Ferranti Electric, Inc., 30 Rockfeller Plaza, New York, N. Y.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
King-Seeley Corp., Ann Arbor, Mich.
Norton Electrical Instrument Corp., 79 Hilliard St., Manchester, Conn.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill. (See Advertisement Page 102)
Supreme Instruments Corp., Greenwood, Miss.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.
Winslow Co., 9 Liberty St., Newark, N. J.

RECORDING AMMETERS

Autocall Co., Shelby, Ohio
Bristol Co., Waterbury, Conn.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Engelhard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
General Electric Co., Schenectady, N. Y. (See Advertisement Pages 7, 15, 19)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Roller-Smith Co., Bethlehem, Pa.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Aids

HEARING AIDS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Laurehk Radio Mfg. Co., 3918 Monroe Ave., Wayne, Mich.
Maico Co., 2632 Nicollet Ave., Minneapolis, Minn.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Telex Products Co., 1645 Hennepin Ave., Minneapolis, Minn.
Trimm Radio Mfg. Co., 1770 W. Berteau Ave., Chicago, Ill.
Western Electric Co.—see Graybar Electric Co.
Zenith Radio Corp., 6011 Dickens Ave., Chicago, Ill.

Albums

RECORD ALBUMS

Columbia Recording Corp., 1475 Barnum Ave., Bridgeport, Conn.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Peerless Album Co., 38 W. 21st St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Wilcox-Gay Corp., Charlotte, Mich.

Aluminum

SHEET, ROD and TUBE ALUMINUM

Aluminum Co. of America, Gulf Bldg., Pittsburgh, Pa.,

Amplifiers

AMPLIFIERS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Amperite Co., 561 Broadway, New York, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Bell Sound Systems, Inc., 1185 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York, N. Y.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Chicago Sound Systems Co., 315 E. Grand Ave., Chicago, Ill.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Electrical Research Products, Inc., 76 Varick St., New York, N. Y.
Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y. (See Advertisement Page 74)
Fulton Radio Corp., 100 Sixth Ave., New York, N. Y.
Gabel Mfg. Co., John, 1200 W. Lake St., Chicago, Ill.
Gates Companies, Quincy, Ill.
General Communication Products Co., Lexington Ave. at Vine, Hollywood, Cal.
General Radio Co., 30 State St., Cambridge, Mass.
Gibbs & Co., Thomas B., 900 W. Lake St., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Jack Mfg. Corp., Charles, 420 Lehigh St., Allentown, Pa.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Marine Radio Corp., 119 168th St., Jamaica, N. Y.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
Morlen Electric Co., 60 W. 15th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
National-Dobro Corp., 400 S. Peoria St., Chicago, Ill.
Norwalk Transformer Corp., South Norwalk, Conn.
Operadio Mfg. Co., St. Charles, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Piezoelectric Laboratories, 612 Rockland Ave., New York, N. Y.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
Rauland Corp., 3341 Belmont Ave., Chicago, Ill.
Ray Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Rowe Industries, 3120 Monroe St., Toledo, Ohio
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Silcox Radio & Television Corp., 60 Wall Tower, New York, N. Y.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Spokane Radio Co., 611 W. First Ave., Spokane, Wash.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Technical Products International, 135 Liberty St., New York, N. Y.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Vega Co., 155 Columbus Ave., Boston, Mass.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.
Webster Electric Co., De Koven Ave. & Clark St., Racine, Wis.
Western Electric Co.—see Graybar Electric Co.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

Analyzers

COLOR ANALYZERS

Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Electronic Products Co., St. Charles, Ill.
Ess Instrument Co., 30 Irving Pl., New York, N. Y.
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Jarrell-Ash Co., 165 Newburg St., Boston, Mass.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio

Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Saxl Instrument Co., 42 Weybosset St., Providence, R. I.
Sheldon Electric Corp., 100 Fifth Ave., New York, N. Y.
United Cinephone Corp., Torrington, Conn.
Woermann-Schuchhardt, Inc., 17 W. 17th St., New York, N. Y.

HARMONIC ANALYZERS

Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett Packard Co., 481 Page Mill Rd., Palo Alto, Calif.
(See Advertisement Page 70)
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Scientific Apparatus Co., 4 Landscape Ave., Yonkers, N. Y.
United Transformer Corp., 150 Varick St., New York, N. Y.

INTERFERENCE and NOISE ANALYZERS

Aerovox Corp., New Bedford, Mass.
American Communications Corp., 123 Liberty St., New York, N. Y.
Amperite Corp., 561 Broadway, New York, N. Y.
Ballantine Laboratories, Inc., Boonton, N. J.
Bendix Radio Corp., 930 E. Fort Ave., Baltimore, Md.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Daven Co., 158 Summit St., Newark, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Electrical Research Products, Inc., 195 Broadway, New York, N. Y.
(See Advertisement Page 152)
Ferris Instrument Corp., Boonton, N. J.
(See Advertisement Page 144)
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Measurements Corp., Boonton, N. J.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
RCA Mfg. Co., Camden, N. J.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.

INDUSTRIAL CIRCUIT ANALYZERS

Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
(See Advertisement Page 138)
Weston Electrical Instrument Co., 614 Frelinghuysen Ave., Newark, N. J.

RADIO SET ANALYZERS

Aerovox Corp., New Bedford, Mass.
Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electrical Research Products, Inc., 76 Varick St., New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
H-W Mfg. Co., 3124 Larga Ave., Los Angeles, Cal.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Measurements Corp., Boonton, N. J.
Meissner Mfg. Co., Mt. Carmell, Ill.
Million Radio & Television Laboratories, 1617 N. Damen Ave., Chicago, Ill.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Radio City Products Co., 88 Park Pl., New York, N. Y.
(See Advertisement Page 141)
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

SOUND SYSTEM ANALYZERS—see Analyzers, Radio Set

TRANSMISSION ANALYZERS

Daven Co., 158 Summit St., Newark, N. J.
(See Advertisement Pages 143 and 152)

Anodes

CARBON ANODES

Keystone Carbon Co., St. Marys, Pa.
National Carbon Co., Carbon Sales Div., Cleveland, Ohio
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Pure Carbon Co., St. Marys, Pa.
Speer Carbon Co., St. Mary's Pa.
(See Advertisement Page 20)
Stackpole Carbon Co., St. Marys, Pa.
Superior Carbon Products, Inc., 9115 George Ave., Cleveland, Ohio
United States Graphite Co., 1621 Holland Ave., Saginaw, Mich.

Antennas

AUTO ANTENNAS

ABC Radio Labs., 3334 N. New Jersey St., Indianapolis, Ind.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Amy, Aceves & King, Inc., 11 W. 42d St., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Fishwick Radio Co., 139 W. Fourth St., Cincinnati, Ohio
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Kraeuter & Co., 585 18th Ave., Newark, N. J.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Premax Products Div., Chisholm-Ryder Co., College & Highland Aves., Niagara Falls, N. Y.
Radiart Corp., W. 62d St. & Barberton Ave., Cleveland, Ohio
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Snyder, Inc., 813 Noble St., Philadelphia, Pa.
Superior Tube Co., Norristown, Pa.
Tilton Electric Corp., 15 E. 26th St., New York, N. Y.
Ward Products Corp., 1523 W. 45th St., Cleveland, Ohio

COUNTERPOISE GROUND SYSTEMS and ANTENNAS

General Electric Co., Schenectady, N. Y.
Hartenstine-Zane Co., 225 Broadway, New York, N. Y.
International-Stacy Corp., 875 Michigan Ave., Columbus, Ohio
Truscon Steel Co., Youngstown, Ohio
Wincharger Corp., 2700 Hawkeye Drive, Sioux City, Iowa

HOME ANTENNAS

ABC Radio Laboratories, 3334 N. New Jersey St., Indianapolis, Ind.
Alden Products Co., 715 Center St., Brockton, Mass.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Amy, Aceves & King, Inc., 11 W. 42d St., New York, N. Y.
Andrea Radio Corp., 4820 48th Ave., Woodside, N. Y.
Bee Engineering Co., 7665 Grand River Ave., Detroit, Mich.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Electric Auto-Lite Co., Wire Div., 3529 24th St., Port Huron, Mich.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Fishwick Radio Co., 139 W. Fourth St., Cincinnati, Ohio
Fleron & Son, M. M., 113 N. Broad St., Trenton, N. J.
Fowler Mfg. Co., 9 Rutger St., St. Louis, Mo.
General Electric Co., Bridgeport, Conn.
General Television & Radio Corp., 1240 N. Homan Ave., Chicago, Ill.
General Winding Co., 254 W. 31st., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Lear Aviation, Inc., Dayton Municipal Airport, Dayton, Ohio
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Norwest Radio Laboratories, Blaine Ave. & Hill St., Shelby, Mont.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Premax Products Div., Chisholm-Ryder Co., College & Highland Aves., Niagara Falls, N. Y.
Quam-Nichols Co., 33d Pl. & Cottage Grove Ave., Chicago, Ill.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Radiart Corp., W. 62d St. & Barberton Ave., Cleveland, Ohio
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sparks-Withington Co., Jackson, Mich.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Technical Appliance Corp., 17 E. 16th St., New York, N. Y.
Vertrod Mfg. Co., 132 Nassau St., New York, N. Y.
Vogue Co., 8134 Vincennes Ave., Chicago, Ill.
Ward Products Corp., 1523 W. 45th St., Cleveland, Ohio

TRANSMITTING ANTENNAS

American Bridge Co., Frick Bldg., Pittsburgh, Pa.
Blaw-Knox Co., Farmers Bank Bldg., Pittsburgh, Pa.
(See Advertisement Page 109)
Graybar Electric Co., Lexington Ave. at 43d St., New York, N.Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hardner Corp., George H., 602 Hamilton St., Allentown, Pa.
Harrell Co., D. H., 10640 Buffalo Ave., Chicago, Ill.
Hartenstine-Zane Co., 225 Broadway, New York, N. Y.
Hoke Vertical Radiator Co., 135 S. Market St., Petersburg, Va.
International-Stacy Corp., 875 Michigan Ave., Columbus, Ohio
Isolantite, Inc., 343 Cortland St., Belleville, N. J.
Johnson Co., E. F., Waseca, Minn.
Lehigh Structural Steel Co., 17 Battery Pl., New York, N. Y.
Lingo & Son, John E., 28th & Buren Ave., Camden, N. J.
(See Advertisement Page 101)
Superior Tube Co., Norristown, Pa.
(See Advertisement Page 24)
Truscon Steel Co., Youngstown, Ohio
Western Electric Co.—see Graybar Electric Co.
Wincharger Corp., 2700 Hawkeye Drive, Sioux City, Iowa
(See Advertisement Page 126)

Attachments

RECORD PLAYER ATTACHMENTS —see Phonographs

Attenuators

see Controls, Volume

Baffles

SPEAKER BAFFLES

Adler Mfg. Co., 2901 W. Chestnut St., Louisville, Ky.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Art Specialty Co., 1115 N. Franklin St., Chicago, Ill.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Castlewood Mfg. Co., 12th & Burnett, Louisville, Ky.
Cinaudigraph Speakers, Inc., 921 W. Van Buren St., Chicago, Ill.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Hadley, Robert M., 711 E. 61st St., Los Angeles, Cal.
Hawley Products Co., 201 N. First Ave., St. Charles, Ill.
Illinois Wood Products Corp., 2512 S. Damen Ave., Chicago, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Ray Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
University Laboratories, 195 Chrystie St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Ballasts

see Tubes, Current Regulating

Batteries

DRY BATTERIES

Acme Battery Corp., 59 Pearl St., Brooklyn, N. Y.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Bond Electric Corp., 146 Munson St., New Haven, Conn.
Bright Star Battery Co., 200 Crooks Ave., Clifton, N. J.
Burgess Battery Co., Freeport, Ill.
Deal Electric Co., 338 Berry St., Brooklyn, N. Y.
Edison Storage Battery Div., Thomas A. Edison, West Orange, N. J.
General Dry Batteries, Inc., 13109 Athens Ave., Cleveland, Ohio
Le Carbone Co., Myrtle Ave., Boonton, N. J.
National Carbon Co., 30 E. 42d St., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Ray-O-Vac Co., Madison, Wis.
Southern Battery Co., Appomattox, Va.
United States Electric Mfg. Corp., 222 W. 14th St., New York, N. Y.
Western Cable & Light Co., Baldwin, Wis.
Winchester Repeating Arms Co., New Haven, Conn.

STORAGE BATTERIES

American Battery Co., 208 W. Kinzie St., Chicago, Ill.
Am-plus Storage Battery Co., 425 W. Superior St., Chicago, Ill.
Bowers Battery Mfg. Co., Reading, Pa.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Edison Storage Battery Div., Thomas A. Edison, Inc., West Orange, N. J.
Electric Storage Battery Co., Allegheny Ave. & 19th St., Philadelphia, Pa.
General Lead Batteries Co., Chapel St. & Lister Ave., Newark, N. J.
General Storage Battery Co., 2005 Locust St., St. Louis, Mo.
Globe Union Inc., 900 E. Keefe Ave., Milwaukee, Wis.
Gould Div., National Battery Co., 35 Neoga St., Depew, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Jumbo Battery Mfrs., Ellsworth, Iowa
K. W. Battery Co., 3705 N. Lincoln Ave., Chicago, Ill.
Marko Storage Battery Corp., 100 Varick Ave., Brooklyn, N. Y.
Monark Battery Co., 4556 W. Grand Ave., Chicago, Ill.
National Battery Co., First National Bank Bldg., St. Paul, Minn.
Philco (Battery Division), Philadelphia, Pa.
Prest-O-Lite Battery Co., 4500 W. 16th St., Indianapolis, Ind.
Solar Corp., 944 W. Bruce St., Milwaukee, Wis.
Universal Battery Co., 3410 S. La Salle St., Chicago, Ill.
USL Battery Corp., 1725 Highland Ave., Niagara Falls, N. Y.
Western Cable & Light Co., Baldwin, Wis.
Willard Storage Battery Co., 246 E. 131st St., Cleveland, Ohio

Beads

INSULATING BEADS

American Lava Corp., Cherokee Blvd. & Manufacturers Rd., Chattanooga, Tenn.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Isolantite Inc., 343 Cortlandt St., Belleville, N. J.
Martindale Electric Co., 1371 Hird Ave., Cleveland, Ohio
Saxonburg Potteries, Saxonburg, Pa.
Star Porcelain Co., 61 Muirhead Ave., Trenton, N. J.
Steward Mfg. Co., D. M., E. 36th St., Chattanooga, Tenn.

Belts

DIAL BELTS—see Cable, Dial

Blocks

TERMINAL BLOCKS — see Posts, Binding

Breakers

CIRCUIT BREAKERS (for electronic applications)

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Autocall Co., Shelby, Ohio
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Burlington Instrument Co., Burlington, Iowa
Cutler-Hammer, Inc., 1401 W. St., Paul Ave., Milwaukee, Wis.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.
(See Advertisement Page 100)
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Penn Electric Switch Co., Goshen, Ind.
Roller-Smith Co., Bethlehem, Pa.
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.

Bridges

ELECTRICAL MEASUREMENT BRIDGES

Aerovox Corp., New Bedford, Mass.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Daven Co., 158 Summit St., Newark, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
(See Advertisement Page 113)
Solar Mfg. Corp., 586 Ave. A, Bayonne, N. J.
Standard Apparatus Co., S. Wentworth Ave. & 51st St., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Thwing-Albert Instrument Co., 3395 Lancaster Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Transformer Corp., 150 Varick St., New York, N. Y.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.

Cabinets

METAL CABINETS

American Communications Corp., 123 Liberty St., New York, N. Y.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
(See Advertisement Page 121)
Erie Can Co., 816 Erie St., Chicago, Ill.
Falstrom Co., 7 Falstrom Court, Passaic, N. J.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johnson Co., E. F. Waseca, Minn.
Karp Products Co., 129 30th St., Brooklyn, N. Y.
(See Advertisement Page 132)
Le Febure Corp., 716 Oakland Blvd., Cedar Rapids, Iowa
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Par Metal Products Corp., 32-62 49th St., Long Island City, N. Y.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
(See Advertisement Page 124)
Tenney Engineering, Inc., 15 Ward St., Bloomfield, N. J.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

PLASTIC CABINETS—see Molders, Plastic

RECORD CABINETS

Chicago Sound Systems Co., 315 E. Grand Ave., Chicago, Ill.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
RCA Mfg. Co., Camden, N. J.
Schloss Bros. Corp., 801 E. 135th St., New York, N. Y.
Tonk Mfg. Co., 1912 N. Magnolia Ave., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

WOOD CABINETS

Adler Mfg. Co., 2901 W. Chestnut St., Louisville, Ky.

Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Castlewood Mfg. Co., 12th & Burnett Sts., Louisville, Ky.
Caswell-Runyan Co., Huntington, Ind.
Chicago Novelty Furniture Co., 1750 N. Campbell Ave., Chicago, Ill.
Churchill Cabinet Co., 2119 W. Churchill St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Illinois Cabinet Co., Rockford, Ill.
Illinois Wood Products Corp., 2512 S. Damen Ave., Chicago, Ill.
Ingraham Co., Bristol, Conn.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
Steger Furniture Mfg. Co., Steger, Ill.
Tillotson Cabinet Co., 1775 Broadway, New York, N. Y.
Waters-Conley Co., 501 First St., Rochester, Minn.
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.

Cable

BATTERY CABLE

Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
American Wire Div., Electric Auto-Lite Co., Port Huron, Mich.
Automotive Specialty Corp., 382 Jefferson St., Brooklyn, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.
Bowes "Seal Fast" Corp., 226 N. Pine St., Indianapolis, Ind.
Bronx Insulated Wire Co., 1169 Webster St., New York, N. Y.
Crescent Cable Co., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton, N. J.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
National Cable & Metal Co., 1727 Standard Ave., Glendale, Cal.
Roebling's Sons Co., John A., Trenton, N. J.
Simplex Wire & Cable Co., 77 Sidney St., Cambridge, Mass.
Sorenson Mfg. Co., P., 21-07 41st Ave., Long Island City, N. Y.
Sterling Cable Div., Electric Auto-Lite Co., Port Huron, Mich.
Western Battery & Supply Co., 4201 Galapago St., Denver, Col.
White, J. M., 1128 Olive St., Philadelphia, Pa.

CO-AXIAL CABLE

American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Johnson Co., E. F., Waseca, Minn.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.

DIAL CABLE

J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Schott Co., Walter L., 5266 W. Pico Blvd., Los Angeles, Cal.

Capacitors

COMPRESSED GAS CAPACITORS

Heintz & Kaufman, Ltd., South San Francisco, Cal.
Lapp Insulator Co., 31 Gilbert St., Le Roy, N. Y.

FIXED CERAMIC CAPACITORS

Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
(See Advertisement Page 75)
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
(See Advertisement Page 83)
General Mfg. Co., Waterbury, Conn.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.

FIXED ELECTROLYTIC CAPACITORS

Aerovox Corp., New Bedford, Mass.
(See Advertisement Page 104)
American Condenser Co., 2508 S. Michigan Ave., Chicago, Ill.
Atlas Condenser Products Co., 548 Westchester Ave., New York, N. Y.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Condenser Corp. of America, 1000 Hamilton Blvd., South Plainfield, N. J.
Condenser Products Co., 1375 N. Branch St., Chicago, Ill.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
(See Advertisement Page 23)
Cosmic Radio Corp., 699 E. 135th St., New York, N. Y.
Crowley & Co., Henry L., 1 Central Ave., West Orange, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Electric Co., 514 Broadway, New York, N. Y.
General Electric Co., Bridgeport, Conn.
Girard-Hopkins, 1437 23d Ave., Oakland, Cal.
H. R. S. Products, 703 N. Cicero Ave., Chicago, Ill.
Illinois Condenser Co., 3252 W. North Ave., Chicago, Ill.
Industrial Condenser Corp., 1725 W. North Ave., Chicago, Ill.
Magnavox Co., 2131 Beuter Rd., Fort Wayne, Ind.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
National Union Radio Corp., 57 State St., Newark, N. J.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Solar Mfg. Corp., 586 Ave. A., Bayonne, N. J.
(See Advertisement Page 8)
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Tilton Electric Corp., 15 E. 26th St., New York, N. Y.

FIXED RECEIVING CAPACITORS

Aerovox Corp., New Bedford, Mass.
(See Advertisement Page 104)
American Condenser Co., 2508 S. Michigan Ave., Chicago, Ill.
Art Radio Corp., 115 Liberty St., New York, N. Y.
Atlas Condenser Products Co., 548 Westchester Ave., New York, N. Y.
Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
(See Advertisement Page 75)
Condenser Products Co., 1375 N. Branch St., Chicago, Ill.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
(See Advertisement Page 23)
Cosmic Radio Corp., 699 E. 135th St., New York, N. Y.
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Electric Co., 514 Broadway, New York, N. Y.
Electro-Motive Mfg. Co., S. Park & John Sts., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
(See Advertisement Page 83)
Fast & Co., John E., 3123 N. Crawford Ave., Chicago, Ill.
General Mfg. Co., Waterbury, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Girard-Hopkins, 1437 23d Ave., Oakland, Cal.
H. R. S. Products, 703 N. Cicero Ave., Chicago, Ill.
Illinois Condenser Co., 3252 W. North Ave., Chicago, Ill.
Industrial Condenser Corp., 1725 W. North Ave., Chicago, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Union Radio Corp., 57 State St., Newark, N. J.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Sevision Magneto Engrg. Co., 379 Phillips Ave., Toledo, Ohio
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Solar Mfg. Corp., 586 Ave. A., Bayonne, N. J.
(See Advertisement Page 8)
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Tilton Electric Corp., 15 E 26th St., New York, N. Y.

FIXED TRANSMITTING CAPACITORS

Aerovox Corp., New Bedford, Mass.
(See Advertisement Page 104)
American Condenser Co., 2508 S. Michigan Ave., Chicago, Ill.
Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
(See Advertisement Page 23)
Deutschmann Corp., Tobe, Canton, Mass.
Dumont Electric Co., 514 Broadway, New York, N. Y.
Fast & Co., John E., 3123 N. Crawford Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Girard-Hopkins, 1437 23d Ave., Oakland, Cal.
H. R. S. Products, 703 N. Cicero Ave., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johnson, E. F., Waseca, Minn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sangamo Electric Co., Springfield, Ill.
Solar Mfg. Corp., 586 Ave. A, Bayonne, N. J.
(See Advertisement Page 8)
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MICA CAPACITORS—see Capacitors, Fixed Receiving

OIL CAPACITORS—see Capacitors, Fixed Transmitting

PAPER CAPACITORS—see Capacitors, Fixed Receiving

TEMPERATURE COMPENSATED CAPACITORS — see Capacitors, Fixed Receiving

VARIABLE RECEIVER TUNING CAPACITORS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Alden Products Co., 715 Center St., Brockton, Mass.
American Steel Package Co., Defiance, Ohio
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
(See Advertisement Page 121)
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
De Wald Radio Mfg. Corp., 436 Lafayette St., New York, N. Y.
General Instrument Corp., 829 Newark Ave., Elizabeth, N. J.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
(See Advertisement Page 132)
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Condenser Co., Savis St. & Copewood Ave., Camden, N. J.
RCA Mfg. Co., Camden, N. J.
Reliance Die & Stamping Co., 1260 Clybourn Ave., Chicago, Ill.

Capacitors

(continued)

VARIABLE TRANSMITTER TUNING CAPACITORS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Barker & Williamson, Ardmore, Pa.
Browning Laboratories, 750 Main St., Winchester, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
(See Advertisement Page 121)
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Heintz & Kaufman, Ltd., South San Francisco, Cal.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johnson, E. F. Waseca, Minn.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
(See Advertisement Page 132)

VARIABLE TRIMMER CAPACITORS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Alden Products Co., 715 Center St., Brockton, Mass.
Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
(See Advertisement Page 121)
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Cardwell Mfg. Corp., Allen D., 81 Prospect St., Brooklyn, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
(See Advertisement Page 75)
De Wald Radio Mfg. Corp., 436 Lafayette St., New York, N. Y.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
Electro-Motive Mfg. Co., S. Park & John Sts., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
General Electric Co., Bridgeport, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Guthman, Inc., E. I., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Industrial Instruments Co., 156 Culver Ave., Jersey City, N. J.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Solar Mfg. Corp., 586 Ave. A, Bayonne, N. J.
(See Advertisement Page 8)
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.

Cells

PHOTO-ELECTRIC CELLS (self-generating)

Bradley Laboratories, 82 Meadow St., New Haven, Conn.
(See Advertisement Page 127)
Burt Scientific Laboratories, R. C., 1212 E. Green St., Pasadena, Cal.
Clark Controller Co., 1146 E. 52d St., Cleveland, Ohio
Continental Electric Co., 715 Hamilton St., Geneva, Ill.
De Jur-Amsco Corp., Shelton, Conn.
De Vry, Herman A., 1111 W. Center St., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
General Scientific Corp., 4829 S. Kedzie Ave., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photovolt Corp., 10 E. 40th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Rhamstine, J. Thos., 301 Beaubien St., Detroit, Mich.
Vacutron, Inc., 20 W. 22d St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
(See Advertisement Page 99)

Cements

RADIO CEMENTS

Alden Products Co., 715 Center St., Brockton, Mass.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Celluloid Corp., 180 Madison Ave., New York, N. Y.
Crowley & Co., Henry L., 1 Central Ave., West Orange, N. J.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Bridgeport, Conn.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
(See Advertisement Page 127)
Meissner Mfg. Co., Mt. Carmel, Ill.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Schott Co., Walter L., 5264 W. Pico Blvd., Los Angeles, Cal.
Stangard Products Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.
Zophar Mills, Inc., 112 26th St., Brooklyn, N. Y.

Ceramics

see Insulation, Ceramic

Changers

AUTOMATIC RECORD CHANGERS

Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Gabel Mfg. Co., John, 1200 W. Lake St., Chicago, Ill.
Garrard Sales Corp., 296 Broadway, New York, N. Y.
General Industries Co., 3537 Taylor St., Elyria, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Rock-Ola Mfg. Corp., 867 N. Kedsie Ave., Chicago, Ill.
Silcox Radio & Television Corp., 60 Wall Tower, New York, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.

Chimes

CHIMES and BELLS

Jack Mfg. Corp., Charles, 420 Lehigh St., Allentown, Pa.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.

Chokes

POWER and AUDIO CHOKES

Acme Electric & Mfg. Co., 16 Water St., Cuba, N. Y.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arlavox Mfg. Co., 430 S. Green St., Chicago, Ill.
Audio Development Co., 123 Bryant Ave., N., Minneapolis, Minn.
Chicago Transformer Corp., 3501 W. Addison St., Chicago, Ill.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Johnson Co., E. F., Waseca, Minn.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Marine Radio Corp., 117 168th St., Jamaica, N. Y.
Miller Co., J. W. 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Norwalk Transformer Corp., South Norwalk, Conn.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Tilton Electric Corp., 15 E. 26th St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Transformer Corp., 150 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

R.F. CHOKES

Aladdin Radio Industries, Inc., 468 W. Superior St., Chicago, Ill.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Barber & Howard, Inc., East Ave., Westerly, R. I.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
Fast & Co., John E., 3101 N. Pulaski Ave., Chicago, Ill.
General Mfg. Co., 1255 S. Michigan Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., E. I., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.

Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.

Clips

GRID CLIPS

Alden Products Co., 715 Center St., Brockton, Mass.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Federal Screw Products Co., 26 S. Jefferson St., Chicago, Ill.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micarta Fabricators, Inc., 4619 Ravenswood Ave., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Mueller Electric Co., 1583 E. 31st St., Cleveland, Ohio
National Co., 61 Sherman St., Malden, Mass.
Smith, Herman, 180 Lafayette St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Coils

POWER and A. F. COILS and WINDINGS

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Barber & Howard, Inc., East Ave., Westerly, R. I.
Best Mfg. Co., 1200 Grove St., Irvington, N. J.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Dano Electric Co., 93 Main St., Winsted, Conn.
Davis & Co., Dean W., 549 W. Fulton St., Chicago, Ill.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
(See Advertisement Page 149)
Electrical Coil Winding Co., 2733 Saunders St., Camden, N. J.
Electrical Products Co., 6535 Russell St., Detroit, Mich.
Electricoil Co., 6 Varick St., New York, N. Y.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Mfg. Co., 1255 S. Michigan Ave., Chicago, Ill.
General Winding Co., 254 W. 31st St., New York, N. Y.
Globe Phone Mfg. Corp., Reading, Pa.
Guthman & Co., Edwin L., 400 S. Peoria St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Instrument Resistors, Inc., Little Falls, N. J.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Light Electric Co., 174 Pennsylvania Ave., Newark, N. J.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
(See Advertisement Page 131)
Majestic Radio & Television Co., 2600 W. 50th St., Chicago, Ill.
Marion Electrical Mfg. Co., 24 Cliff St., Jersey City, N. J.
Meissner Mfg. Co., Mt. Carmel, Ill.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Electric Coil Co., 794 Chambers Rd., Columbus, Ohio
Norwalk Transformer Corp., South Norwalk, Conn.
(See Advertisement Page 80)
Phelps Dodge Copper Products Corp., American Copper Products Div., 40 Wall St., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Premier Crystal Laboratories, Inc., 55 Park Row, New York, N. Y.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Robertson-Davis Co., 311 N. Desplaines St., Chicago, Ill.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York, N. Y.
Webster Electric Co., Racine, Wis.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.

R.F. RECEIVING or TRANSMITTING COILS

Aladdin Radio Industries, Inc., 468 W. Superior St., Chicago, Ill.
Alden Products Co., 715 Center St., Brockton, Mass.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
General Mfg. Co., 1255 S. Michigan Ave., Chicago, Ill.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., Edwin L., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johnson, E. F., Waseca, Minn.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Meissner Mfg. Co., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
(See Advertisement Page 132)
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.

SOLENOID COILS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Automatic Switch Co., 41 E. 11th St., New York, N. Y.
Cannon Electric Development Co., 3209 Humbolt St., Los Angeles, Cal.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Davis & Co., Dean W., 549 W. Fulton St., Chicago, Ill.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
Electrical Coil Winding Co., 2733 Saunders St., Camden, N. J.
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Instrument Resistors, Inc., Little Falls, N. J.
Jefferson Electric Co., Bellwood, Ill.
National Acme Co., 170 E. 131st St., Cleveland, Ohio
Square D Co., 6060 Rivard St., Detroit, Mich.
Supreme Electric Products Corp., 105 Mt. Hope Ave., Rochester, N. Y.
Trombetta Solenoid Co., 419 E. Clybourn St., Milwaukee, Wis.

Colorimeters

PHOTO-ELECTRIC COLORIMETERS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Electronic Products Co., St. Charles, Ill.
Frober-Faybor Co., Chagrin Falls, Ohio
Jarrell-Ash Co., 165 Newburg St., Boston, Mass.
Klett Mfg. Co., 179 E. 87th St., New York, N. Y.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Saxl Instrument Co., 42 Weybosset St., Providence, R. I.
Scientific Glass Apparatus Co., Bloomfield, N. J.
United Cinephone Co., Torrington, Conn.
Woermann-Schuchhardt, Inc., 17 W. 17th St., New York, N. Y.

Color-Matchers

see Colorimeters, Photo-Electric

Condensers

see Capacitors

Connectors

CABLE CONNECTORS

Alden Products Co., 715 Center St., Brockton, Mass.
American Microphone Co., 1915 S. Western Ave., Los Angeles, Cal.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cannon Electric Development Co., 3209 Humbolt St., Los Angeles, Cal.
(See Advertisement Page 21)
Eastern Mike-Stand Co., 56 Christopher Ave., Brooklyn, N. Y.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Electro Voice Mfg. Co., 1239 S. Bend Ave., South Bend, Ind.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
(See Advertisement Page 132)
Pyle-National Co., 1334 N. Kostner Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Selectar Mfg. Corp., 30 W. 15th St., New York, N. Y.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sherman Mfg. Co., H. B., 22 Barney St., Battle Creek, Mich.
Turner Co., 909 17th St., N. E., Cedar Rapids, Iowa
Webster Electric Co., De Koven Ave. & Clark St., Racine, Wis.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Controls

AUTO RADIO CONTROLS

Alden Products Co., 715 Center St., Brockton, Mass.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Dual Remote Control Co., 31776 W. Warren St., Wayne, Mich.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Stewart Mfg. Corp., F. W., 4311 Ravenswood Ave., Chicago, Ill.
United Motors Service, 3044 W. Grand Blvd., Detroit, Mich.
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y.

Controls, Indicators and Other Electronic Devices

BOILER GAUGE LEVEL ALARMS

Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Co., Torrington, Conn.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

BURGLAR ALARMS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Scientific Corp., 4829 S. Kenzie Ave., Chicago, Ill.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.

ACIDITY and ALKALINITY CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

BLEACHING PROCESS CONTROLS

Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.

DOOR OPENER CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
General Scientific Corp., 4829 S. Kenzie Ave., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.

DRINKING FOUNTAIN CONTROLS

G. M. Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.

FURNACE CONTROLS

General Electric Co., Schenectady, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

GUNFIRE CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.

HEAT TREATING CONTROLS

Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

LIGHTING CONTROLS

Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
General Scientific Corp., 4829 S. Kenzie Ave., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

MOTOR or GENERATOR CONTROLS

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Andrews & Perillo, Inc., 3930 Crescent St., Long Island City, N. Y.
Burlington Instrument Corp., Burlington, Iowa
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.
United Cinephone Corp., Torrington, Conn.

PAPER TRIMMING and SLITTING CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Co., Torrington, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PHOTOGRAPHIC PROCESS CONTROLS

General Control Co., 243 Broadway, Cambridge, Mass.
Industrial Timer Corp., 117 Edison Pl., Toledo, Ohio
Intercontinental Marketing Corp., 95 Madison Ave., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

PRINTING REGISTER CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

TELESCOPE DIRECTION CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

TEMPERATURE CONTROLS

Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Electro-Medical Laboratories, Holliston, Mass.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Illinois Testing Laboratories, 420 N. La Salle St., Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

THICKNESS CONTROLS

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.

TRAFFIC CONTROLS

American Gas Accumulator Co., Elizabeth, N. J.
Eagle Signal Corp., Moline, Ill.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

VIBRATION CONTROLS

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

WEFT STRAIGHTENING CONTROLS

General Electric Co., Schenectady, N. Y.

WELDING CONTROLS

Allis-Chalmers Mfg. Co., Milwaukee, Wisc.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

COUNTERS

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
Clare Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Control Co., 243 Broadway, Cambridge, Mass.
General Scientific Corp., 4829 S. Kenzie Ave., Chicago, Ill.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

METAL and GUN DETECTORS

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.

SHEET STEEL PINHOLE DETECTORS

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

GRADING DEVICES

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Control Co., 243 Broadway, Cambridge, Mass.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.

KEYING DEVICES

Gray Mfg. Co., 16-30 Arbor St., Hartford, Conn.

MACHINE SAFETY DEVICES

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Control Co., 243 Broadway, Cambridge, Mass.
Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

TIMING DEVICES

Automatic Electric Co., 1033 W. Van Buren St., Chicago, Ill.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
Intercontinental Marketing Corp., 95 Madison Ave., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.

WEIGHING DEVICES

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
General Control Co., 243 Broadway, Cambridge, Mass.

United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

PHOTOTUBE RELAYS

Andrews & Perillo, Inc., 39-30 Crescent St., Long Island City, N. Y.
Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Electronic Products Co., St. Charles, Ill.
General Control Co., 243 Broadway, Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

TIME DELAY RELAYS

American Gas Accumulator Co., Elizabeth, N. J.
Eagle Signal Corp., Moline, Ill.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.

LIMIT SWITCHES

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
United Cinephone Corp., Torrington, Conn.

PACKAGE WRAPPING

Electronic Control Corp., 626 Harper Ave., Detroit, Mich.
G-M Laboratories, Inc., 1735 Belmont Ave., Chicago, Ill.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

INDUSTRIAL ELECTRONIC CONTROLS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Industrial Timer Corp., 117 Edison Pl., Newark, N. J.
United Cinephone Corp., Torrington, Conn.
Wallace & Tiernan Co., Belleville, N. J.

PUSH BUTTON MECHANICAL CONTROLS

American Emblem Co., Utica, N. Y.
American Steel Package Co., Squire Ave., Defiance, Ohio
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
General Instrument Corp., 829 Newark Ave., Elizabeth, N. J.
Oak Mfg. Co., 1260 Clybourn Ave., Chicago, Ill.

PUSH BUTTON TRIMMER CONTROLS

Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Winding Co., 900 Passaic Ave., East Newark, N. J.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., E. I., 400 S. Peoria St., Chicago, Ill.
Meissner Mfg. Co., Mt. Carmel, Ill.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Sparks-Withington Co., Jackson, Mich.
Teleradio Engrg. Corp., 484 Broome St., New York, N. Y.

RADIO REMOTE CONTROLS—see Controls, Remote

REMOTE CONTROLS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Arca Regulators, Inc., 600 Forest St., Arlington, N. J.
Askania Regulator Co., 1603 S. Michigan Ave., Chicago, Ill.
Autocall Co., Shelby, Ohio
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4536 Wayne Ave., Philadelphia, Pa.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Electric Indicator Corp., 21 Parker Ave., Stamford, Conn.
Electrimatic Corp., 2100 Indiana Ave., Chicago, Ill.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Elsbert Mfg. Co., 910 W. Lake St., Chicago, Ill.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Hagan Corp., Bowman Bldg., Pittsburgh, Pa.
Hanlon-Waters, Inc., Tulsa, Okla.
Hart Mfg. Co., 11 Bartholomew Ave., Hartford, Conn.
Hays Corp., 925 Eighth Ave., Michigan City, Ind.
H-B Instrument Co., 2520 N. Broad St., Philadelphia, Pa.
Illinois Engineering Co., Racine Ave. & 20th Pl., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
International Filter Co., 325 25th Pl., Chicago, Ill.
Kollsman Instrument Div., Square D Co., 8008 45th Ave., Elmhurst, N. Y.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Meissner Mfg. Co., Mt. Carmel, N. Y.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Perfex Corp., 415 W. Oklahoma Pl., Milwaukee, Wis.
Photobell Corp., 123 Liberty St., New York, N. Y.
Powers Regulator Co., 2720 Greenview Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago, Ill.
Scientific Instrument Co., 1441 Walnut St., Berkeley, Cal.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Taylor Instrument Companies, 100 Ames St., Rochester, N. Y.
United Cinephone Corp., Torrington, Conn.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.
Zenith Electric Co., 835 S. Wabash St., Chicago, Ill.

VOLUME CONTROLS

Audio Products Co., 2101 S. Olive St., Burbank, Cal.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
(See Advertisement Page 75)
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
(See Advertisement Page 145)
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Daven Co., 158 Summit St., Newark, N. J.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Leeds & Nothrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Remler Co., 2101 Bryant St., San Francisco, Cal.
(See Advertisement Page 144)
Rowe Radio Research Laboratory Co., 1103 Bryn Mawr Ave., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

Converters

ROTARY CONVERTERS—see Dynamotors

Cord

RADIO CORD

Alden Products Co., 715 Center St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
Aluminum Co. of America, Grant Bldg., Pittsburgh, Pa.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
American Electric Cable Co., Holyoke, Mass.
American Metal Moulding Co., 146 Colt St., Irvington, N. J.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Ansonia Electrical Wire Co., Ansonia, Conn.
Audio Development Co., 1033 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 137)
Austin Co., M. B., 108 S. Des Plaines St., Chicago, Ill.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 71)
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bishop Wire & Cable Co., 420 E. 25th St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St. (Dorchester), Boston, Mass.
(See Advertisement Page 142)
Camden Wire Co., Camden, N. J.
Circle Wire & Cable Corp., Maspeth, Ave., Maspeth, N. Y.
Clarostat Mfg. Co., 285 N. Sixth St., Brooklyn, N. Y.
Collyer Insulated Wire Co., 249 N. Main St., Pawtucket, R. I.
Columbia Cable & Electric Co., Manly St., Long Island City, N. Y.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Copperweld Steel Co., Glassport, Pa.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Cable Co., Front & Central Ave., Pawtucket, R. I.
Crescent Insulated Wire & Cable Co., N. Olden Ave. & Taylor St., Trenton, N. J.
Diamond Wire & Cable Co., Lowe Ave., Chicago, Heights, Ill.
Driver-Harris Co., Harrison, N. J.
Essex Wire Corp., 37 Manchester St., Detroit, Mich.
Gavitt Mfg. Co., Brookfield, Mass.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Insulated Wire Co., 69 Gordon Ave., Providence, R. I.
Goldmark Wire Co., James, 116 West St., New York, N. Y.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Whitney Blake Co., New Haven, Conn.)
Guthman Co., Edwin I., 400 S. Peoria St., Chicago, Ill.
Habirshaw Cable & Wire Corp., 40 Wall St., New York, N. Y.
Hatfield Wire & Cable Co., Hillside, N. J.
Hazard Insulated Wire Works, Div. of The Okonite Co., Wilkes-Barre, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
J. F. D. Mfg. Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kennecott Wire & Cable Co., Phillipsdale, R. I.
Kerite Insulated Wire & Cable Co., Seymour, Conn.
Knickerbocker Annunciator Co., 116 West St., New York, N. Y.
Lenhart Mfg. Co., Hamburg, Pa.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.
Midland Wire Corp., 70 Hunter St., Tiffin, Ohio.
National Electric Products Corp., Fulton Bldg., Pittsburgh, Pa.
New England Cable Co., Concord, N. H.
New Eng. Electric Works, Lisbon, N. H.
New York Insulated Wire Co., 295 Madison Ave., New York, N. Y.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
Okonite Co., Passaic, N. J.
Packard Electric Div., General Motors Corp., Warren, Ohio
Paranite Wire & Cable Corp., Jonesboro, Ind.
Phelps Dodge Copper Products Corp., American Copper Products Div., 40 Wall St., New York, N. Y.
Philadelphia Insulated Wire Co., 220 N. Third St., Philadelphia, Pa.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., Trenton, N. J.

Cord

RADIO CORD (Continued)

Rome Cable Corp., Rome, N. Y.
Runzel Cord & Wire Co., 4729 Montrose Ave., Chicago, Ill.
Simplex Wire & Cable Corp., 79 Sidney St., Cambridge, Mass.
Sterling Cable Corp., Port Huron, Mich.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Triangle Conduit & Cable Co., Horace Harding & Queens Blvds., Elmhurst, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York, N. Y.
Upson Walton Co., 1286 W. 11th St., Cleveland, Ohio
Walker Bros., Conshohocken, Pa.
Walker's Copper Cable Co., 1416 Venice Blvd., Los Angeles, Cal.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.
White, J. M., 1116 Olive St., Philadelphia, Pa.
Whitney Blake Co.—see Graybar Electric Co.
York Insulated Wire Works Div. of General Electric Co., York, Pa.

Cords

RADIO and APPLIANCE CORDS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Beaver Mfg. Co., 727 Frelinghuysen Ave., Newark, N. J.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Collyer Insulated Wire Co., Pawtucket, R. I.
Deal Electric Co., 338 Berry St., Brooklyn, N. Y.
Diamond Wire & Cable Co., Chicago Heights, Ill.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Ericson Mfg. Co., 5716 Euclid Ave., Cleveland, Ohio
Gem Electric Mfg. Co., 453 Broome St., New York, N. Y.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hatfield Wire & Cable Co., 605 Hillside Ave., Hillside, N. J.
Holyoke Wire & Cable Corp., 720 Main St., Holyoke, Mass.
Hoosick Falls Radio & Electrical Parts Mfg. Co., First St., Hoosick Falls, N. Y.
Marks Products Co., 84 N. Ninth St., Brooklyn, N. Y.
Monowatt Electric Corp., 570 Lexington Ave., New York, N. Y.
Paranite Wire & Cable Corp., Jonesboro, Ind.
Paulding, Inc., John I., New Bedford, Mass.
Rodale Mfg. Co., Sixth & Minor Sts., Emaus, Pa.
Royal Electric Co., 95 Grand Ave., Pawtucket, R. I.
United States Rubber Co., 1230 Sixth Ave., New York, N. Y.
Utah Radio Products Co., 820 N. Orleans Ave., Chicago, Ill.
Waterbury Button Co., Waterbury, Conn.
Woody Mfg. Co., 5639 N. Ashland Ave., Chicago, Ill.
Wood Electric Co., C. D., 826 Broadway, New York, N. Y.

Cores

POWDERED IRON CORES

Advance Solvents & Chemical Corp., 245 Fifth Ave., New York, N. Y.
(See Advertisement Page 85)
Ferrocart Corp. of America, Williams St., & Aqueduct Lane, Hastings-on-Hudson, N. Y.
(See Advertisement Page 146)
Stackpole Carbon Co., Tannery St., St. Marys, Pa.
(See Advertisement Page 103)

Couplings

CO-AXIAL CABLE COUPLINGS — see ANTENNA Connectors, Cable

Crystals

QUARTZ CRYSTALS (frequency controlling)

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
Bausch & Lomb Optical Co., 635 St. Paul St., Rochester, N. Y.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Bliley Electric Co., Union Station Bldg., Erie, Pa.
(See Advertisement Page 118)
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Burnett Radio Laboratory, Wm. W. L., 4814 Idaho St., San Diego, Cal.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co. New York, N. Y.)
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
Hipower Crystal Co., 2035 W. Charleston St., Chicago, Ill.
(See Advertisement Page 149)
Hunt & Sons, G. C., Carlisle, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Miller, August E., 9226 Hudson Blvd., North Bergen, N. J.
National Co., 61 Sherman St., Malden, Mass.
Petersen Radio Co., Council Bluffs, Iowa
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Piezoelectric Laboratories, 612 Rockland Ave., New York, N. Y.
Precision Crystal Laboratories, 1211 Liberty St., Springfield, Mass.
Precision Piezo Service, 427 Asia St., Baton Rouge, La.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Scientific Radio Service, 124 Jackson Ave., University Park, Hyattsville, Md.
Standard Piezo Co., Louther & Cedar Sts., Carlisle, Pa.
Valpey Crystals, Holliston, Mass.
Western Electric Co.—see Graybar Electric Co.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

ROCHELLE SALT CRYSTALS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio

TOURMALINE CRYSTALS

Fuess, Inc., R., 39 W. 60th St., New York, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

Dials

COMPLETE DIALS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Alden Products Co., 715 Center St., Brockton, Mass.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Emblem Co., Utica, N. Y.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bastian Bros. Co., 1600 N. Clinton Ave., Rochester, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Erie Resistor Corp., Erie, Pa.
Flock Process Corp., 17 W. 31st St., New York, N. Y.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Hunter Pressed Steel Co., Landsdale, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
(See Advertisement Page 132)
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Premier Crystal Laboratories, Inc., 55 Park Row, New York, N. Y.
Rex Rheostat Co., 37 W. 20th St., New York, N. Y.
Silicocks-Miller Co., 10 Parker Ave., W. South Orange, N. J.

Diathermy

DIATHERMY

American Systocope Makers, Inc., 1241 Lafayette Ave., Bronx, N. Y.
Battle Creek Equipment Co., 32 N. Washington Ave., Battle Creek, Mich.
Birtcher Corp., 5087 Huntington Drive, N., Los Angeles, Cal.
Burdick Corp., Milton, Wis.
de Forest Laboratories, Lee, 5106 Wilshire Blvd., Los Angeles, Cal.
Ecco High Frequency Corp., 120 W. 20th St., New York, N. Y.
Fischer & Co., H. G., 2323 Wabansia Ave., Chicago, Ill.
General X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Hanovia Chemical & Mfg. Co., N. J. R. R. Ave. & Chestnut St., Newark, N. J.
Herz-Lasker Corp., 17 W. 60th St., New York, N. Y.
High Tension Corp., 118 W. 22d St., New York, N. Y.
Kelley-Koett Mfg. Co., Covington, Ky.
Lektra Laboratories, Inc., 30 E. Tenth St., New York, N. Y.
Lepel High Frequency Laboratories, Inc., 39 W. 60th St., New York, N. Y.
Majestic Surgical Instrument Co., 2608 N. Cicero Ave., Chicago, Ill.
McIntosh Electrical Corp., 223 N. California Ave., Chicago, Ill.
Mueller & Co., V., 408 S. Honore St., Chicago, Ill.
Peerless Laboratories, Inc., 115 E. 23d St., New York, N. Y.
Rose Mfg. Co., E. J., 727 E. Gage Ave., Los Angeles, Cal.
Sharp & Smith, Hospital Div., A. S. Aloe Co., 1813 Olive St., St. Louis, Mo.

Discs

BLANK RECORDING DISCS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Allied Recording Products Co., 21-09 43d Ave., Long Island City, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Cook, F. L., 606 Parkman Ave., Los Angeles, Cal.
Duotone Co., 799 Broadway, New York, N. Y.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electrovox Co., 424 Madison Ave., New York, N. Y.
Emeloid Mfg. Co., Arlington, N. J.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Federal Recorder Co., Elkhart, Ind.
Galvin Mfg. Corp., 4545 W. August Blvd., Chicago, Ill.
Gould-Moody Corp., 395 Broadway, New York, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Home Recording Co., 9 E. 19th St., New York, N. Y.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Poinsettia, Inc., 95 Cedar Ave., Pitman, N. J.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radio Specialties Co., 1956 S. Figueroa St., Los Angeles, Cal.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.

Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Recordisc Corp., 395 Broadway, New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Cal.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sound Devices Co., 160 E. 116th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Talking Devices Co., 4451 Irving Park Rd., Chicago, Ill.
United States Record Corp., 1780 Broadway, New York, N. Y.
Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.
Wilcox-Gay Corp., Charlotte, Mich.

Dividers

VOLTAGE DIVIDERS—see Resistors

Dynamotors

DYNAMOTORS, GENEMOTORS, ROTARY CONVERTERS

Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
Carter Motor Co., 1608 N. Milwaukee Ave., Chicago, Ill.
(See Advertisement Page 114)
Delco Appliance Div., General Motors Sales Corp., 391 Lyell Ave., Rochester, N. Y.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Diehl Mfg. Co., Trumbell & First Sts., Elizabethport, N. J.
Eclipse Aviation Div. of Bendix Aviation Corp., Bendix, N. J.
Elcor, Inc., 1060 W. Adams St., Chicago, Ill.
(See Advertisement Page 124)
Electric Specialty Co., 211 South St., Stamford, Conn.
General Electric Co., Schenectady, N. Y.
Janette Mfg. Co., 558 W. Monroe St., Chicago, Ill.
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
Onan & Sons, D. W., 792 Royalston Ave., Minneapolis, Minn.
(See Advertisement Page 93)
Pioneer Gen-E-Motor Corp., 5849 Dickens Ave., Chicago, Ill.
(See Advertisement Page 117)
RCA Mfg. Co., Camden, N. J.

Electrocardiographs

ELECTROCARDIOGRAPHS

Beck-Lee Corp., 630 W. Jackson Blvd., Chicago, Ill.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Herz-Lasker Corp., 17 W. 60th St., New York, N. Y.
Mueller & Co., V., 408 S. Honore St., Chicago, Ill.
Sanborn Co., 39 Osborn St., Cambridge, Mass.

Enamels

INSULATING ENAMELS

(See also Varnish, Insulating)

Alden Products Co., 715 Center St., Brockton, Mass.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Irvington Varnish & Insulator Co., 18 Argyle Terrace, Irvington, N. J.
(See Advertisement Page 98)
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
(See Advertisement Page 127)
Roxalin Flexible Lacquer Co., Elizabeth, N. J.
Schott Co., Walter L., 5264 W. Pico Blvd., Los Angeles, Cal.
Stangard Products Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.

Equalizers

see Filters, Equalizer

Equipment

DRAFTING ROOM EQUIPMENT

All-Steel-Equip Co., 641 John St., Aurora, Ill.
Alteneder Co., Theo., 1217 Spring Garden St., Philadelphia, Pa.
Arkwright Finishing Co., Turks Head Bldg., Providence, R. I.
Brown & Sharpe Mfg. Co., 235 Promenade St., Providence, R. I.
Bruning Co., Charles, 100 Reade St., New York, N. Y.
Calibron Products, Inc., West Orange, N. J.
Cardinell Corp., Montclair, N. J.
Carter's Ink Co., Kendall Square, Boston, Mass.
Coxhead Corp., Ralph C., 333 Sixth Ave., New York, N. Y.
Dietzgen Co., Eugene, 2425 Sheffield Ave., Chicago, Ill.
Drafto Co., Cochranton, Pa.
Dremel Mfg. Co., 14th & Clark Sts., Racine Wis.
Emmert Mfg. Co., Waynesboro, Pa.
Eraser Co., 936 University Block, Syracuse, N. Y.
Faber Co., A. W., Dickerson & Bittman Sts., Newark, N. J.
Faber Pencil Co., Eberhard, 37 Greenpoint Ave., Brooklyn, N. Y.
Gurley, W. & L. E., Troy, N. Y.
Hamilton Mfg. Co., Two Rivers, Wis.
Higgins Ink Co., 271 Ninth St., Brooklyn, N. Y.
Holliston Mills, Inc., Norwood, Mass.
Hunt & Son Co., C. B., Salem, Ohio
Keuffel & Esser Co., 303 Adams St., Hoboken, N. J.
(See Advertisement Page 3)
Koh-I-Noor Pencil Co., 373 Fourth Ave., New York, N. Y.
Lyon Metal Products, Inc., 1933 Montgomery St., Aurora, Ill.
Ozalid Products Div., General Aniline & Film Corp., 25 Ansco Rd., Johnson City, N. Y.
Paragon-Revolute Corp., 77 South Ave., Rochester, N. Y.
Pease Co., C. F., 2679 W. Irving Park Rd., Chicago, Ill.
Phillips Process Co., 192 Mill St., Rochester, N. Y.
Post Co., Frederick, 3650 Avondale Ave., Chicago, Ill.
Shaw Blue Print Machine Co., 11 Campbell St., Newark, N. J.
Speidel & Co., Chas. W., 112 N. 12th St., Philadelphia, Pa.
Stafford, Inc., S. S., 607 Washington St., New York, N. Y.
Starrett Co., L. S., 165 Crescent St., Athol, Mass.
United States Blue Print Paper Co., 207 S. Wabash Ave., Chicago, Ill.
Universal Drafting Machine Co., 1426 W. Third St., Cleveland, Ohio
Weber Co., F., 1220 Buttonwood St., Philadelphia, Pa.
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y.
Wickes Bros., 512 N. Water St., Saginaw, Mich.
Williams, Brown & Earle, Inc., 918 Chestnut St., Philadelphia, Pa.
Wood-Regan Instrument Co., Nutley, N. J.
Wright, Inc., L. G., 5209 Euclid Ave., Cleveland, Ohio

REMOTE CONTROL EQUIPMENT—see Controls, Remote

Escutcheons

ESCUTCHEONS

Alden Products Co., 715 Center St., Brockton, Mass.
American Emblem Co., Utica, N. Y.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago, Ill.
Erie Resistor Corp., Erie, Pa.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Liberty Engraving & Mfg. Co., 2911 S. Central Ave., Los Angeles, Cal.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Syracuse Ornamental Co., Syracuse, N. Y.

Exciters

SPEAKER FIELD EXCITERS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Fulton Radio Corp., 100 Sixth Ave., New York, N. Y.
Norwalk Transformer Corp., South Norwalk, Conn.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Ray-Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.

Faces

DIAL FACES—see Scales, Dial

Fibre

VULCANIZED FIBRE

Brandywine Fibre Products Co., N. Walnut St., Wilmington, Del.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
(See Advertisement Page 11)
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
Insulation Mfg. Corp., 365 W. Washington Blvd., Chicago, Ill.
Lincoln Fibre & Specialty Co., Newport, Del.
National Vulcanized Fibre Co., Wilmington, Del.
(See Advertisement Page 91)
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Taylor Fibre Co., Norristown, Pa.
(See Advertisement Page 144)
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

Filters

ELECTRIC WAVE SECTION FILTERS

Bliley Electric Co., Union Station Bldg., Erie, Pa.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
United Transformer Corp., 150 Varick St., New York, N. Y.

EQUALIZER FILTERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Daven Co., 158 Summit St., Newark, N. J.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
United Transformer Corp., 150 Varick St., New York, N. Y.

RADIO SET FILTERS

Aerovox Corp., New Bedford, Mass.
American Communications Corp., 123 Liberty St., New York, N. Y.
Atlas Condenser Products Co., 548 Westchester Ave., New York, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.

Filters

RADIO SET FILTERS (continued)

Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Ferris Instrument Corp., Boonton, N. J.
General Winding Co., 254 W. 31st St., New York, N. Y.
Girard-Hopkins, 1437 23d Ave., Oakland, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Meissner Mfg. Co., Mt. Carmel, Ill.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
New York Transformer Co., 480 Lexington Ave., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Solar Mfg. Corp., 586 Ave. A., Bayonne, N. J.
Sprague Specialties Co., 189 Beaver St., North Adams, Mass.
Stangard Products Co., 4111 Fort Hamilton Pkwy., Brooklyn, N. Y.
Technical Appliance Corp., 17 E. 16th St., New York, N. Y.
Tefft Radio Co., Plymouth, Mich.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Whisk Laboratories, 145 W. 45th St., New York, N. Y.

Finishes

LACQUER FINISHES

Alrose Chemical Co., Providence, R. I.
Apollo Metal Works Co., 6601 S. Oak Park Ave., Chicago, Ill.
Arco Co., 7301 Bessemer Ave., Cleveland, Ohio
Ault & Wiborg Corp., 75 Varick St., New York, N. Y.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Berry Bros., Inc., 211 Leib St., Detroit, Mich.
Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
du Pont de Nemours & Co., E. I., 626 Schuyler Ave., Arlington, N. J.
Durez Plastics & Chemicals, Inc., Walck Road, North Tonawanda, N. Y.
Egyptian Lacquer Mfg. Co., 1270 Sixth Ave., New York, N. Y.
Ferro Enamel Corp., 4150 E. 56th St., Cleveland, Ohio
Franklin Paint & Varnish Co., Benjamin, 4820 Langdon St., Philadelphia, Pa.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
Glidden Co., 11100 Glidden Ave., Cleveland, Ohio
Haynes Laboratories, Inc., C. W., Springfield, Mass.
Hilo Varnish Corp., 42 Stewart Ave., Brooklyn, N. Y.
Jones-Dabney Co., Smith & Proback Sts., Louisville, Ky.
Kay & Ess Co., Leo & Kiser Sts., Dayton, Ohio
Larkin Co., 680 Seneca St., Buffalo, N. Y.
Lilly Varnish Co., 670 S. California St., Indianapolis, Ind.
Lowe Brothers Co., 436 E. Third St., Dayton, Ohio
Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.
(See Advertisement Page 127)
Makalot Corp., 262 Washington St., Boston, Mass.
Masury & Son, John W., 50 Jay St., Brooklyn, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
Murphy Varnish Co., 224 McWhorter St., Newark, N. J.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
New Wrinkle, Inc., Mutual Home Bldg., Dayton, Ohio
Pierce & Stevens, Inc., Swing St., Buffalo, N. Y.
Pittsburgh Plate Glass Co., Grant Bldg., Pittsburgh, Pa.
Plaskon Co., 2112 Sylvan Ave., Toledo, Ohio
Pratt & Lambert, Inc., 92 Tonawanda St., Buffalo, N. Y.
Roxalin Flexible Lacquer Co., 802 Magnolia Ave., Elizabeth, N. J.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio.
Stanley Chemical Co., East Berlin, Conn.
Walker Co., H. V., 714 Division St., Elizabeth, N. J.
Watson-Standard Co., 225 Galveston St., Pittsburgh, Pa.
Zapon Div., Atlas Powder Co., Ludlow St., Stamford, Conn.

Forks

ELECTRICALLY DRIVEN TUNING FORKS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.

Forms

COIL FORMS

Alden Products Co., 715 Center St., Brockton, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
Erie Resistor Corp., 640 W. 12th St., Erie, Pa.
Fast & Co., John E., 3101 N. Pulaski Ave., Chicago, Ill.
General Ceramics Co., 30 Rockefeller Plaza, New York, N. Y.
General Mfg. Co., 1255 S. Michigan Ave., Chicago, Ill.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., E. I., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Paramount Paper Tube Co., 801 Glasgow Ave., Fort Wayne, Ind.
Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.
Synthane Corp., Highland Ave., Oaks, Pa.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Fuses

INSTRUMENT FUSES

Bussmann Mfg. Co., University at Jefferson, St. Louis, Mo.
Chase-Shawmut Co., Newburyport, Mass.
Littelfuse, Inc., 4757 Ravenswood Ave., Chicago, Ill.
Meter Devices Co., 1001 Prospect Ave., S.W., Canton, Ohio

Galvanometers

GALVANOMETERS

Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
De Jur-Amsco Corp., Shelton, Conn.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Heiland Research Corp., Club Bldg., Denver, Col.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio.
J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Measurements Corp., Boonton, N. J.
National Technical Laboratories, 820 Mission St., Pasadena, Cal.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Thwing-Albert Instrument Co., 3395 Lancaster Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.

Generators

SIGNAL GENERATORS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Bendix Marine Products Div., Bendix Aviation Corp., 754 Lexington Ave., Brooklyn, N. Y.
Boonton Radio Corp., Boonton, N. J.
(See Advertisement Page 147)
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Ferris Instrument Corp., Boonton, N. J.
(See Advertisement Page 144)
General Radio Co., 30 State St., Cambridge, Mass.
(See Advertisement Page 16)
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Measurements Corp., Boonton, N. J.
(See Advertisement Page 133)
Million Radio & Television, 1617 N. Damen Ave., Chicago, Ill.
Monarch Mfg. Co., 3341 Belmont Ave., Chicago, Ill.
(See Advertisement Page 150)
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Radio City Products Co., 88 Park Pl., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Simpson Electric Co., 5216 W. Kinzie St. Chicago, Ill.
Telviso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplet Electrical Instru. Co., 286 Harmon Rd., Bluffton, Ohio
(See Advertisement Page 131)
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Cinephone Co., Torrington, Conn.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.

SQUARE WAVE GENERATORS

General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Measurements Corp., Boonton, N. J.

Geophones

GEOPHONES

Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Globe Phone Mfg. Corp., Reading, Mass.
Heiland Research Corp., Club Bldg., Denver, Col.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas

Graphite

COLLOIDAL GRAPHITE

Acheson Colloids Corp., Port Huron, Mich. (See Advertisement Page 123)
Asbury Graphite Mills, Asbury, N. J.
Grafo Colloids Corp., Sharon, Pa.
Superior Flake Graphite Co., First National Bank Bldg., Chicago, Ill.

Harnesses

WIRE HARNESSES

Alden Products Co., 715 Center St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
R. B. M. Mfg. Co., Div. Essex Wire Corp., Logansport, Ind.
Rupp's Assembling & Mfg. Works, 2341 N. Seminary Ave., Chicago, Ill.
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y. (See Advertisement Page 124)

Headphones

CRYSTAL HEADPHONES

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio (See Advertisement Page 86)
Connecticut Telephone & Electric Co., 70 Britannia St., Meriden, Conn.
Telex Products Co., 1645 Hennepin Ave., Milwaukee, Wis.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.

DYNAMIC HEADPHONES

Carrier Microphone Co., 439 S. La Brea Ave., Inglewood, Cal.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.

MAGNETIC HEADPHONES

Allied Raido Corp., 833 W. Jackson Blvd., Chicago, Ill.
Cannon Co., C. F., Springwater, N. Y.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Connecticut Telephone & Electric Co., 70 Britannia St., Meriden, Conn.
Electrical Industries Mfg. Co., Red Bank, N. J.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Trimm Radio Mfg. Co., 1770 W. Berteau Ave., Chicago, Ill.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.

Heads

CUTTING HEADS

Astatic Microphone Laboratories, Inc., 830 Market St., Youngstown, Ohio
Audak Co., 500 Fifth Ave., New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio (See Advertisement page 86)
Electrical Industries Mfg. Co., Red Bank, N. J.
Fairchild Aviation Corp., 88–06 Van Wyck Blvd., Jamaica, N. Y.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Mellaphone Corp., 65 Atlantic Ave., Rochester, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., B. A., 230 Park Ave., New York, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
RCA Mfg. Co., Camden, N. J.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.
Webster Electric Co., De Koven Ave. & Clark St., Racine, Wis. (See Advertisement Page 90)
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

RECORDING HEADS—see Heads, Cutting

Holders

CRYSTAL HOLDERS—see Crystals

Horns

SPEAKER PROJECTOR HORNS

American Communications Corp., 123 Liberty St., New York, N. Y.
Art Specialty Co., 1115 N. Franklin St., Chicago, Ill.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y. (See Advertisement Page 151)
Castlewood Mfg. Co., 12th & Burnett, Louisville, Ky.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hawley Products Co., 201 N. First Ave., St. Charles, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill. (See Advertisement Page 77)
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 167 N. Damen St., Chicago, Ill.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Oxford-Tartak Radio Corp., 915 W. Van Buren St., Chicago, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Rowe Industries, 3120 Monroe St., Toledo, Ohio
Sherron Metallic Corp., 1201 Flushing Ave., Brooklyn, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
University Laboratories, 195 Chrystie St., New York, N. Y.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.
Western Electric Co.—see Graybar Electric Co.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Indicators

CONDENSER LEAKAGE INDICATORS

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

NEON INDICATORS

Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Littelfuse, Inc., 4757 Ravenswood Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.

OUTPUT INDICATORS—see Meters, Output

POSITION INDICATORS

Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bendix Marine Products Div., Bendix Aviation Corp., 754 Lexington Ave., Brooklyn, N. Y.
Boston Auto Gage Co., 70 West St., Pittsfield, Mass.
Electric Indicator Corp., 21 Parket Ave., Stamford, Conn.
Electric Speed Indicator Co., 16313 Laverne Ave., Lakewood, Ohio
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Pioneer Instrument Div. of Bendix Aviation Corp., Bendix, N. J.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

POWER LEVEL INDICATORS

Clough-Brengle Co., 501 Broadway, Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

PRESSURE INDICATORS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Commercial Engineering Laboratories, 4612 Woodward Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.

SMOKE DENSITY INDICATORS and RECORDERS

Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Ess Instrument Co., 30 Irving Pl., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Television Corp., 70 Brookline Ave., Boston, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lumenite Electric Co., Old Colony Bldg., Chicago, Ill.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
McNeil Engineering Equipment Co., T. W., 4057 W. Van Buren St., Chicago, Ill.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Preferred Utilities Mfg. Corp., 31 W. 60th St., New York, N. Y.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

VOLUME INDICATORS

Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Instruments

AUTOMOTIVE SERVICE INSTRUMENTS

Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.
Bear Mfg. Co., Rock Island, Ill.
Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)

Instruments

AUTOMOTIVE SERVICE INSTRUMENTS (continued)

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Engelhard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Hays Corp., 925 Eighth Ave., Michigan City, Ind.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton Rogers Co.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

GEOPHYSICAL INSTRUMENTS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Geophysical Instrument Co., 1315 Half St., S.E., Washington, D. C.
Heiland Research Corp., Club Bldg., Denver, Col.
Mico Instrument Co., 10 Arrow St., Cambridge, Mass.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Cal.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.

Insulation

ACOUSTICAL INSULATION—see Insulation, Sound

CERAMIC INSULATION

Akron Porcelain Co., Cory Ave. & Belt Line, Akron, Ohio
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
(See Advertisement Page 27)
Ceramic Specialties Co., East Liverpool, Ohio
Colonial Insulator Co., 931 Grant St., Akron, Ohio
Cook Ceramic Mfg. Co., Prospect St. & P. R. R., Trenton, N. J.
General Ceramics Co., 30 Rockefeller Plaza, New York, N. Y.
(See Advertisement Page 97)
General Porcelain Co., 951 Pennsylvania Ave., Trenton, N. J.
Hartford Faience Co., 175 Bartholomew Ave., Hartford, Conn
Illinois Electric Porcelain Co., Macomb, Ill.
Imperial Porcelain Works, Inc., Mulberry St. & New York Ave., Trenton, N. J.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Knox Porcelain Corp., 200 Mynderse Ave., Knoxville, Tenn.
Lapp Insulator Co., 32 Gilbert St., Le Roy, N. Y.
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.
McDanel Refractory Porcelain Co., Beaver Falls, Pa.
Metsch Refractories Co., East Liverpool, Ohio
Mycalex Corp. of America, 7 E. 42d St., New York, N. Y.
Parker, J. H., 27 Park Pl., New York, N. Y.
Porcelain Insulator Corp., 123 E. Main St., Lima, N. Y.
Porcelain Products, Inc., Parkersburg, W. Va.
Porcelier Mfg. Co., Greensburg, Pa.
Saxonburg Potteries, Saxonburg, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Square D Co., 6060 Rivard St., Detroit, Mich.
Star Porcelain Co., 61 Muirhead Ave., Trenton, N. J.
Thomas & Sons Co., R., E. Washington St., Lisbon, Ohio
Union Electrical Porcelain Works, Inc., Van Ave., Trenton, N. J.
Universal Clay Products Co., 1505 E. First St., Sandusky, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

GLASS INSULATION

Bentley, Harris Mfg. Co., Conshohocken, Pa.
Corning Glass Works, Corning, N. Y.
(See Advertisement Page 22)
Hope Webbing Co., Providence, R. I.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Owens-Corning Fiberglas Corp., Nicholas Bldg., Toledo, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PAPER INSULATION

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
Brandywine Fibre Products Co., N. Walnut St., Wilmington, Del.
Case Bros., Highland Park, Conn.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Cottrell Paper Co., 19 Purchase St., Fall River, Mass.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hartford City Paper Co., Hartford City, Ind.
Insulation Mfg. Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Lincoln Fibre & Specialty Co., Newport, Del.
Manning Paper Co., John A., Troy, N. Y.
Mica Insulator Co., 200 Varick St., New York, N. Y.
National Vulcanized Fibre Co., Wilmington, Del.
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Riegel Paper Corp., 342 Madison Ave., New York, N. Y.
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Taylor Fibre Co., Norristown, Pa.
(See Advertisement Page 144)
West Virginia Pulp & Paper Co., 230 Park Ave., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

PHENOLIC INSULATION

Celluloid Corp., 10 E. 40th St., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
(See Advertisement Page 11)
Dow Chemical Co., Midland, Mich.
Formica Insulation Co., 4662 Spring Grove Ave., Cincinnati, Ohio
(See Advertisement Page 14)
Mica Insulator Co., 200 Varick St., New York, N. Y.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Goodyear Tire & Rubber Co., 1144 E. Market St., Akron, Ohio
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
(See Advertisement Page 98)
Mica Insulator Co., 200 Varick St., New York, N. Y.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
National Vulcanized Fibre Co., Wilmington, Del.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Orrsell Co., 64 E. Eighth St., New York, N. Y.
Panelyte Corp., 230 Park Ave., New York, N. Y.
Penn Fibre & Specialty Co., 2030 E. Westmoreland St., Philadelphia, Pa.
Richardson Co., Lockland, Cincinnati, Ohio
Spaulding Fibre Co., 310 Wheeler St., Tonawanda, N. Y.
Synthane Corp., River Rd., Oaks, Pa.
(See Advertisement Page 67)
Taylor Fibre Co., Norristown, Pa.
(See Advertisement Page 144)
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilmington Fibre Specialty Co., P. O. Box 944, Wilmington, Del.

SOUND INSULATION

Celetox Corp., 919 N. Michigan Ave., Chicago, Ill.
Insulite Co., Builders Exchange Bldg., Minneapolis, Minn.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Masonite Corp., Cellufoam Products Div. 6565 S. Lavergne Ave., Chicago, Ill.
United States Gypsum Co., 300 W. Adams St., Chicago, Ill.

Insulators

GUY and TRANSMISSION LINE INSULATORS

Alden Products Co., 715 Center St., Brockton, Mass.
American Lava Corp., Kruesi Bldg., Chattanooga, Tenn.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Corning Glass Works, Corning, N. Y.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Isolantite, Inc., 343 Cortlandt St., Belleville, N. J.
Lapp Insulator Co., 32 Gilbert St., Le Roy, N. Y.
(See Advertisement Page 25)
Locke Insulator Corp., S. Charles & Cromwell Sts., Baltimore, Md.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Mims Radio Co., Texarkana, Ark.
National Co., 61 Sherman St., Malden, Mass.
Radiart Corp., W. 26th St. & Barberton Ave., Cleveland, Ohio

MAST FOOTING and TOWER INSULATORS

Lapp Insulator Co., Gilbert St., Le Roy, N. Y.
(See Advertisement Page 25)
Locke Insulator Corp., Baltimore, Md.

Intercommunicators

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
American Television Corp., 130 W. 56th St., New York, N .Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Autocall Co., Shelby, Ohio
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cannon Electric Development Co., 3209 Humbolt St., Los Angeles, Cal.
Chicago Sound Systems Co., 315 E. Grand Ave., Chicago, Ill.
Communication Equipment & Engrg. Co., 504 N. Parkside Ave., Chicago, Ill.
Connecticut Telepphone & Electric Corp., 70 Britannia St., Meriden, Conn.
De Wald Radio Mfg. Corp., 436 Lafayette St., New York, N. Y.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electronic Products Co., St. Charles, Ill.
Elkay Mfg. Corp., 200 Fifth Ave., New York, N. Y.
Gibbs & Co., Thomas B., 900 W. Lake St., Chicago, Ill.
Intercall Systems, Inc., Fifth & Norwood, Dayton, Ohio
Karadio Corp., 2323 Chestnut St., Oakland, Cal.
Lake Mfg. Co., 2323 Chestnut St., Oakland, Cal.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Operadio Mfg. Co., St. Charles, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radio Recepter Co., 251 W. 19th St., New York, N. Y.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Sillcox Radio & Television Corp., 60 Wall Tower, New York, N. Y.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Telemotor Corp., 260 Fifth Ave., New York, N. Y.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.

Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.
Webster Electric Co., De Koven Ave. & Clark St., Racine, Wis.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

Inverters

INVERTERS

American Television & Radio Corp., 300 E. Fourth St., St. Paul Minn.
Electrical Products Co., 6535 Russell St., Detroit, Mich.
Electronic Laboratories, Inc., 122 W. New York St., Indianapolis, Ind.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.

Irons

ELECTRIC SOLDERING IRONS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Adrola Corp., Adrola Bldg., Port Jefferson, N. Y.
All Rite Co., Morgan & First Sts., Rushville, Ind.
American Electrical Heater Co., 6110 Cass Ave., Detroit, Mich.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Cole Radio Works, 86 Westville Ave., Caldwell, N. J.
Dominion Electrical Mfg. Co., 22 Elm St., Mansfield, Ohio
Drake Electric Works, 3656 Lincoln Ave., Chicago, Ill.
Dual Remote Control Co., 31776 W. Warren St., Wayne, Mich.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Electric Soldering Iron Co., 205 W. Elm St., Deep River, Conn.
General Electric Co., Schenectady, N. Y.
Hexacon Electric Appliance Corp., 163 W. Clay Ave., Roselle Park, N. J.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jackson Electro Corp., 625 Broadway, New York, N. Y.
Kay Co., J. H., 121 Second St., San Francisco, Cal.
Landers, Frary & Clark, 47 Center St., New Britain, Conn.
Lenk Mfg. Co., Newton Lower Falls, Mass.
Northern Electric Co., 5224 N. Kedzie Ave., Chicago, Ill.
Ohio Art Co., Bryan, Ohio
Samson-United Corp., 8 Jones St., Rochester, N. Y.
Stanley Tools, Div. of Stanley Works, New Britain, Conn.
Sta-Warm Electric Co., 565 N. Chestnut St., Ravenna, Ohio
Suttle Equipment Co., Lawrenceville, Ill.
Trent Co., Harold E., 55th St. & Wyalusing Ave., Philadelphia, Pa.
Vasco Electrical Mfg. Co., 4116 Avalon Blvd., Los Angeles, Cal.
Vulcan Electric Co., 600 Broad St., Lynn, Mass.
Ward Mfg. Co., 1813 Winona Ave., Chicago, Ill.
Wellmade Electric Mfg. Co., Railroad Sq. & Church St., Torrington, Conn.

Jacks

JACKS

American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carter Radio Co., 812 Orleans St., Chicago, Ill.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
General Radio Co., 30 State St., Cambridge, Mass.
Johnson Co., E. F., Waseca, Minn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Smith, Herman, 180 Lafayette St., New York, N. Y.
Standard Electric Mfg. Co., 925 Wrightwood Ave., Chicago, Ill.
Technical Appliance Corp., 17 E. 16th St., New York, N. Y.
Yaxley Mfg. Div. Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.

Knobs

KNOBS

Alden Products Co., 715 Center St., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Davies Molding Co., Harry, 1428 N. Wells St., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Erie Resistor Corp., Erie, Pa.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
General Radio Co., 30 State St., Cambridge, Mass.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio City Products Co., 88 Park Pl., New York, N. Y.
Radio Knob Co., 43 E. Ohio St., Chicago, Ill.
Richardson Co., 27th & Lake Sts., Melrose Park, Ill.
Rogen Brothers, 180 N. Wacker Drive, Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sillcocks-Miller Co., 10 Parker Ave., W., South Orange, N. J.
Syracuse Ornamental Co., Syracuse, N. Y.

Laminations

see Stampings, Metal

Lamps

DIAL LAMPS

Alden Products Co., 715 Center St., Brockton, Mass.
American Radio Tube Co., 115 Liberty St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carlton Lamp Corp., 811 30th St., Union City, N. J.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
National Union Radio Corp., 57 State St., Newark, N. J.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Tung-Sol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.

Lights

PILOT LIGHTS

Alden Products Co., 715 Center St., Brockton, Mass.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Bryant Electric Co., 1421 State St., Bridgeport, Conn.
Circle F Mfg. Co., 720 Monmouth St., Trenton, N. J.
Dial Light Co. of America, Inc., 92 West St., New York, N. Y.
Drake Mfg. Co., 1713 W. Hubbard St., Chicago, Ill.
(See Advertisement Page 117)
Federal Screw Products, 26 S. Jefferson St., Chicago, Ill.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Hubbell, Inc., Harvey, State St. & Bostwick Ave., Bridgeport, Conn.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kirkland Co., H. R., Morristown, N. J.
(See Advertisement Page 149)
Pass & Seymour, Inc., Solvay Station, Syracuse, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Signal Indicator Co., 140 Cedar St., New York, N. Y.
(See Advertisement Page 149)
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Locators

INTERFERENCE LOCATORS—see **Analyzers** Interference

Locknuts

see **Nuts**, Self-Locking

Loudspeakers

LOUDSPEAKERS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Arlavox Mfg. Co., 430 S. Green St., Chicago, Ill.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
(See Advertisement Page 151)
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
Best Mfg. Co., 1200 Grove St., Irvington, N. J.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Cinaudagraph Speakers, Inc., 921 W. Van Buren St., Chicago, Ill.
Crescent Industries, Inc., 4140 W. Belmont Ave., Chicago, Ill.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Fibre Form, Inc., Columbia City, Ind.
Fulton Radio Co., 100 Sixth Ave., New York, N. Y.
Gates Companies, Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hawley Products Co., 201 N. First Ave., St. Charles, Ill.
Jensen Radio Mfg. Co., 6601 S. Laramie Ave., Chicago, Ill.
(See Advertisement Page 77)
Leotone Radio Co., 63 Dey St., New York, N. Y.
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Oxford-Tartak Radio Corp., 915 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 120)
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Permoflux Corp., 4916 W. Grand Ave., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Quam-Nichols Co., 33d Pl. & Cottage Grove Ave., Chicago, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Radio Speakers, 221 E. Cullerton St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Rola Co., 2530 Superior Ave., Cleveland, Ohio
Rowe Industries, 3120 Monroe St., Toledo, Ohio

Loudspeakers

LOUDSPEAKERS (continued)

Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
University Laboratories, 195 Chrystie St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vac-O-Grip Co., 2023 Detroit Ave., Toledo, Ohio
Western Electric Co.—see Graybar Electric Co.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.
Wright-Decoster, Inc., 2233 University Ave., St. Paul, Minn.

Lugs

COPPER TERMINAL LUGS

Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Burndy Engineering Co., 459 E. 133d St., New York, N. Y.
Dante Electric Mfg. Co., Bantam, Conn.
Dossert & Co., 242 W. 41st., New York, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia, Pa.
Electrical Engineers Equipment Co., 25th Ave. & Division St., Melrose Park, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Grammes & Sons, Inc., L. F., 344 Union St., Allentown, Pa.
Ideal Clamp Mfg. Co., 202 Bradford St., Brooklyn, N. Y.
Ilsco Copper Tube & Products, Inc., 5629 Madison Rd., Cincinnati, Ohio
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Kliegl Bros. Universal Electric Stage Lighting Co., 321 W. 50th St., New York, N. Y.
Krueger & Hudepohl, 232-8 Vine St., Cincinnati, Ohio
Morse Co., Frank W., 301 Congress St., Boston, Mass.
Multi Electrical Mfg. Co., 1840 W. 14th St., Chicago, Ill.
Patton-MacGuyer Co., Baker St. & Virginia Ave., Providence, R. I.
Penn-Union Electric Corp., 315 State St., Erie, Pa.
Rajah Co., Locust Ave., Bloomfield, N. J.
Risdon Mfg. Co., Naugatuck, Conn.
Shain, Chas. D., 145 Beach, 119th St., Bell Harbor, N. Y.
Shakeproof Lock Washer Co., 2565 N. Keeler Ave., Chicago, Ill.
Sherman Mfg. Co., H. B., Battle Creek, Mich.
Square D Co., 6060 Rivard St., Detroit, Mich.
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zierick Mfg. Corp., 385 Gerard Ave., New York, N. Y.

Machines

COIL WINDING MACHINES

Armature Coil Equipment, Inc., 2605 Vega Ave., Cleveland, Ohio
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
Chapman Electrical Works, P. E., 1820 Chouteau Ave., St. Louis, Mo.
Conran, Frederick M., 107 Colden St., Newark, N. J.
Electric Service Supplies Co., 17th & Cambria Sts., Philadelphia, Pa.
General Electric Specialty Co., 184-01 Hillside Ave., Hollis, N. Y.
Guthman & Co., Edwin I., 400 S. Peoria St., Chicago, Ill.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Potter & Rayfield, Inc., Hemphill Ave., Atlanta, Ga.
Seifert, Inc., E. R., 315 E. Washington St., Syracuse, N. Y.
Universal Winding Co., 1655 Elmwood Ave., Providence, R. I.
Viking Tool & Machine Co., Mill & Main Sts., Belleville, N. J.

ELECTRON TUBE MANUFACTURING MACHINES

Distillation Products, Inc., 1735 Ridge Rd., W., Rochester, N. Y.
Eisler Engineering Co., 751 S. 13th St., Newark, N. J.
(See Advertisement Page 149)
Kahle Engineering Corp., 1307 Seventh St., North Bergen, N. J.

RECORDING MACHINES

Acoustic Consultants, Inc., 1270 Sixth Ave., New York, N .Y.
Air King Products Co., 1523 63d St., Brooklyn, N. Y.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Allied Recording Products Co., 21-09 43d Ave., Long Island City, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Bateman Sound Systems, 680 Johnston St., Akron, Ohio
Bell Sound Systems, Inc., 1185 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York, N. Y.
Brush Development, 3311 Perkins Ave., Cleveland, Ohio
De Vry, Herman A., 1111 W. Center St., Chicago, Ill.
Electrical Industries Mfg. Co., Red Bank, N. J.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
(See Advertisement Page 74)
Federal Recorder Co., Elkhart, Ind.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
McDonald Recording & Engrg. Service, 415 N. Harper Ave., Los Angeles, Cal.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Meissner Mfg. Co., Mt. Carmel, Ill.
Mellaphone Corp., 65 Atlantic Ave., Rochester, N. Y.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
(See Advertisement Page 149)
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Pacific Sound Equipment Co., 7373 Melrose Ave., Hollywood, Cal.
Piezoelectric Laboratories, 612 Rockland Ave., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., B. A., 230 Park Ave., New York, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Cal.
Rek-O-Kut Corp., 173 Lafayette St., New York, N. Y.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Scully Machine Co., 62 Walter St., Bridgeport, Conn.
Seattle Radio Supply, Inc., 2117 Second Ave., Seattle, Wash.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Selectar Mfg. Corp., 30 W. 15th St., New York, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Spokane Radio Co., 611 W. First Ave., Spokane, Wash.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.
Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.
Wilcox-Gay Corp., Charlotte, Mich.
Zenith Radio Corp., 6011 Dickens Ave., Chicago, Ill.

Magnesium

MAGNESIUM

Aluminum Co. of America, Gulf Bldg., Pittsburgh, Pa.
American Magnesium Corp., 2210 Harvard Ave., Cleveland, Ohio
Belmont Smelting & Refining Works, Inc., 323 Belmont Ave., Brooklyn, N. Y.
Bohn Aluminum & Brass Corp., Lafayette Bldg., Detroit, Mich.
Dow Chemical Co., Midland, Mich.

Magnets

PERMANENT MAGNETS

Crucible Steel Co. of America, 405 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Indiana Steel Products Co., 135 S. La Salle St., Chicago, Ill.
Taylor-Wharton Iron & Steel Co., Highbridge, N. J.
Thomas & Skinner Steel Products Co., 1120 E. 23d St., Indianapolis, Ind.
(See Advertisement Page 143)

Megohmmeters

MEGOHMMETERS—see Ohmeters

Metals

PRECIOUS METALS

American Electro Metal Corp., 320 Yonkers Ave., Yonkers, N. Y.
(See Advertisement Page 82)
American Platinum Works, New Jersey R. R. Ave., at Oliver St., Newark, N. J.
(See Advertisement Page 133)
Baker & Co., Murray & Austin Sts., Newark, N. J.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
(See Advertisement Page 68)
Cohn, Sigmund, 44 Gold St., New York, N. Y.
Cross, H., New York, N. Y.
(See Advertisement Page 149)
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Handy & Harman, 82 Fulton St., New York, N. Y.
Independent Contact Mfg. Co., 540 39th St., Union City, N. J.
International Nickel Co., 67 Wall St., New York, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Wilson Co., H. A., 97 Chestnut St., Newark, N. J.

THERMOSTATIC METALS

Baker & Co., Murray & Austin Sts., Newark, N. J.
Brainin Co., C. S., 20 Van Dam St., New York, N. Y.
(See Advertisement Page 123)
Callite Tungsten Corp., 544 39th St., Union City, N. J.
(See Advertisement Page 68)
Chace Co., W. M., 1608 Beard Ave., Detroit, Mich.
Dole Valve Co., 1941 Carroll Ave., Chicago, Ill.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J.
(See Advertisement Page 130)

FABRICATED METAL PRODUCTS

Lewyt Metal Products Co., 64 Broadway, Brooklyn, N. Y.
(See Advertisement Page 5)

Meters

ELECTRONIC METERS

Ballantine Laboratories, Inc., Boonton, N. J.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

FOOT CANDLE METERS—see Meters, Light

FREQUENCY CONTROLLING METERS

General Electric Co., Schenectady, N. Y.
Leeds & Northup Co., 4970 Stenton Ave., Philadelphia, Pa.
RCA Mfg. Co., Camden, N. J.

FREQUENCY ELECTRONIC METERS

Browning Laboratories Inc., 750 Main St., Winchester, Mass.
De Jur-Amsco Corp., Shelton, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.

FREQUENCY INDICATING METERS

Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
(See Advertisement Page 114)
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

FREQUENCY RECORDING METERS

Bristol Co., Waterbury, Conn.
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Leeds & Northup Co., 4970 Stenton Ave., Philadelphia, Pa.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

FREQUENCY STANDARD METERS

Bliley Electric Co., Union Station Bldg., Erie, Pa.
Ferris Instrument Corp., Boonton, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Millen Mfg. Co., 150 Exchange St., Malden, Mass.
RCA Mfg. Co., Camden, N. J.

FREQUENCY VIBRATING REED METERS

Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
(See Advertisement Page 114)
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

IGNITION VELOCITY METERS

Hays Corp., 925 Eighth Ave., Michigan City, Ind.
Southwestern Electronic Laboratories, 2326 Guadalupe St., Austin, Tex.

ILLUMINATION METERS — see Meters, Light

Also **Recorders,** Illumination

INDUCTANCE METERS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

LIGHT METERS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Applied Research Laboratories, 1208 San Julian St., Los Angeles, Cal.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
De Jur-Amsco Corp., Shelton, Conn.
Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
Gaertner Scientific Corp., 1201 Wrightwood Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Jarrell-Ash Co., 165 Newburg St., Boston, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Parr Instrument Co., 222 52d St., Moline, Ill.
Pfaltz & Bauer, Inc., 350 Fifth Ave., New York, N. Y.
Phipps & Bird, Inc., Richmond, Va.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
Pho-Tron Instrument Co., 5713 Euclid Ave., Cleveland, Ohio
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Southwestern Electronics Laboratories, 2326 Guadalupe St., Austin, Tex.
United Cinephone Corp., Torrington, Conn.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

MODULATION METERS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Weston Electric Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

OUTPUT METERS

Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
(See Advertisement Pages 143 and 152)
Dejur-Amsco Corp., Shelton, Conn.
Electrical Research Products, Inc., 76 Varick St., New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Bridgeport, Conn.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio City Products Co., 88 Park Pl., New York, N. Y.
Radio Design Co., 1353 Sterling Pl., Brooklyn, N. Y.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, 136 E. College Ave., Bluffton, Ohio
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sterling Mfg. Co., 9205 Detroit Ave., Cleveland, Ohio
Superior Instruments Co., 136 Liberty St., New York, N. Y.
Supreme Instruments Corp., 414 Howard St., Greenwood, Miss.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Corp., 122 Main St., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl 4358 W. Roosevelt Rd., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

PHASE ANGLE METERS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
RCA Mfg. Co., Camden, N. J.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

"Q" METERS—see "Q"-Meters

RADIO FREQUENCY METERS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Lampkin Laboratories, Bradenton, Fla.
(See Advertisement Page 139)
Measurements Corp., Boonton, N. J.
Millen Mfg. Co., 150 Exchange St., Malden, Mass.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Co., 4545 Bronx Blvd., New York, N. Y.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd.
Weston Electrical Instrument Corp., 621 Frelinghuysen Ave., Newark, N. J.

REACTANCE METERS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Therm-Electric Meters Co., Ithaca, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SOUND LEVEL METERS — see Meters, Output

TIME METERS

Cramer Co., R. W., Centerbrook, Conn.
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
Jaeger Watch Co., 304 E. 45th St., New York, N. Y.
National Instrument Co., 44 School St., Boston, Mass.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
(See Advertisement Page 127)
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Warren Telechron Co., 252 Main St., Ashland, Mass.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

ULTRAVIOLET RADIATION METERS

General Electric Co., Schenectady, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

VU METERS—see Meters, Output

Mica

MICA

Asheville Mica Co., 5 River Rd., Biltmore, N. C.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
English Mica Co., 220 E. 42d St., New York, N. Y.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Huse-Liberty Mica Co., 171 Camden St., Boston, Mass.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Macallen Co., 25 Macallen St., Boston, Mass.
Mica Co. of Canada (N. Y.), Inc., Massena, N. Y.
Mica Insulator Co., 200 Varick St., New York, N. Y.
(See Advertisement Page 73)
Mica Mfg. Co., Sperry Bldg., Brooklyn, N. Y.
Mica Products Mfg. Co., 139 Spring St., New York, N. Y.
Munsell & Co., Eugene, 200 Varick St., New York, N. Y.
New England Mica Co., Waltham, Mass.
New Hampshire Mica & Mining Co., Washington St., Keene, N. H.
Richardson Co., 27th & Lake Sts., Melrose Park, Ill.
Schoonmaker Insulation Co., A. O., 635 Greenwich St., New York, N. Y.
Southern Mica Co., Johnson City, Tenn.
Spruce Pine Mica Co., Spruce Pine, N. C.
Tar Heel Mica Co., Plumtree, N. C.
U. S. Mica Mfg. Co., 1521 Circle Ave., Forest Park, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Microammeters

see Ammeters

Microfaradmeters

see Bridges, Electrical Measurement

Micrometers

ELECTRONIC MICROMETERS

Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.

Microphones

MICROPHONES

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Microphone Co., 1915 S. Western Ave., Los Angeles, Cal. (See Advertisement Page 135)
Amperite Co., 561 Broadway, New York, N. Y.
Astatic Microphone Laboratory, 830 Market St., Youngstown, Ohio (See Advertisement Page 108)
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bogen & Co., David, 663 Broadway, New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio (See Advertisement Page 86)
Carrier Microphone Co., 439 S. La Brea Ave., Inglewood, Cal.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electro-Voice Mfg. Co., 1239 South Bend Ave., South Bend, Ind.
Ephiphone, Inc., 142 W. 14th St., New York, N. Y.
Galvin Mfg. Corp., 4545 W. Augusta Blvd., Chicago, Ill.
Gates Companies, Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.) (See Advertisement Pages 93 and 112)
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Lektra Laboratories, Inc., 30 E. 10th St., New York, N. Y.
Leotone Radio Co., 63 Dey St., New York, N. Y.
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
National-Dobro Corp., 400 S. Peoria St., Chicago, Ill.
Olson Mfg. Co., 362 Wooster Ave., Akron, Ohio
Operadio Mfg. Co., St. Charles, Ill.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
RCA Mfg. Co., Camden, N. J.
Rowe Industries, Inc., 3120 Monroe St., Toledo, Ohio
Seattle Radio Supply, Inc., 2117 Second Ave., Seattle, Wash.
Shure Bros., 225 W. Huron St., Chicago, Ill.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Tibbetts Laboratories, Camden, Me.
Transducer Corp., 42 W. 48th St., New York, N. Y.
Turner Co., 909 17th St., N.E., Cedar Rapids, Iowa
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Vega Co., 155 Columbus Ave., Boston, Mass.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.
Webster-Chicago Corp., 5622 Bloomingdale St., Chicago, Ill.
Webster Electric Co., De Koven Ave. & Clark St., Racine, Wis.
Western Electric Co.—see Graybar Electric Co.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.

Milliammeters

see Ammeters

Milliohmmeters

see Ohmmeters

Mixers

MIXERS

Bogen & Co., David, 663 Broadway, New York, N. Y.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
RCA Mfg. Co., Camden, N. J.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Western Electric Co.,—see Graybar Electric Co.

Monitors

BROADCASTING MONITORS

Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill. (See Advertisement Page 129)
Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Radio Engineering Laboratories, Inc., 35–54 36th St., Long Island City, N. Y.
RCA Mfg. Co., Camden, N. J.

Motor-Generators

see Dynamotors

Motors

FRACTIONAL HORSEPOWER MOTORS

Air-Way Electric Appliance Corp., 2101 Auburn Ave., Toledo, Ohio
Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Allis Co., Louis, 427 E. Stewart St., Milwaukee, Wis.
Armor Electric Mfg. Co., 1020 Holland St., Erie, Pa.
Baldor Electric Co., 4370 Duncan Ave., St. Louis, Mo.
Barber-Colman Co., River & Loomis Sts., Rockford, Ill.
Black & Decker Electric Co., Kent, Ohio
Bodine Electric Co., 2262 W. Ohio St., Chicago, Ill.
B & R Mfg. Co., Toledo Factories Bldg., Toledo, Ohio
Brown-Brockmeyer Co., 1000 S. Smithville Rd., Dayton, Ohio
Burke Electric Co., 12th & Berry Sts., Erie, Pa.
Canatsey Electric Mfg. Co., 620 Wyandotte St., Kansas City, Mo.
Century Electric Co., 1806 Pine St., St. Louis, Mo.
Crocker-Wheeler Electric Mfg. Co., Ampere, N. J.
Delco Appliance Division, General Motors Sales Corp., 391 Lyell Ave., Rochester, N. Y.
Delco Products Div., General Motors Corp., 329 E. First St., Dayton, Ohio
Diehl Mfg. Co., Trumbull & First Sts., Elizabethport, N. J.
Dumore Co., 14th & Racine Sts., Racine, Wis.
Electric Motor Corp., Racine, Wis.
Electric Specialty Co., 211 South St., Stamford, Conn.
Electro Dynamic Works of Electric Boat Co., Ave. A & North St., Bayonne, N. J.
Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis, Mo.
Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill.
Fidelity Electric Co., 332 N. Arch St., Lancaster, Pa.
Franklin Transformer Mfg. Co., 607 22d Ave., N. E., Minneapolis, Minn.
General Electric Co., Schenectady, N. Y.
Hansen Mfg. Co., Princeton, Ind.
Haydon Mfg. Co., Forrestville, Conn.
Heinze Electric Corp., Lowell, Mass.
Holtzer-Cabot Electric Co., 125 Amory St., Boston, Mass.
Howell Electric Motors Co., Howell, Mich.
Janette Mfg. Co., 558 W. Monroe St., Chicago, Ill.
Kendrick & Davis Co., Lebanon, N. H.
Kimble Electric Co., 2023 W. Hastings St., Chicago, Ill.
Kingston-Conley Electric Co., 68 Brook Ave., North Plainfield, N. J.
Leich Electric Co., Genoa, Ill.
Leland Electric Co., Dayton, Ohio
Marathon Electric Mfg. Corp., 32 Island St., Wausau, Wis.
Master Electric Co., 126 Davis Ave., Dayton, Ohio
Merkel-Korff Gear Co., 213 N. Morgan St., Chicago, Ill.
Motorstat Electric Corp., 5005 Euclid Ave., Cleveland, Ohio
Northwestern Electric Co., 408 S. Hoyne Ave., Chicago, Ill.
Ohio Electric Mfg. Co., 5900 Maurice Ave., Cleveland, Ohio
Peerless Electric Co., 740 W. Market St., Warren, Ohio
Redmond Co., A. G., Owosso, Mich.
Reliance Electric & Engineering Co., 1084 Ivanhoe Rd., Cleveland, Ohio
Reynolds Electric Co., 2650 W. Congress St., Chicago, Ill.
Robbins & Myers, 1345 Lagonda Ave., Springfield, Ohio
Russell Electric Co., 340 W. Huron St., Chicago, Ill.
Signal Electric Mfg. Co., 1915 Broadway, Menominee, Mich.
Smith Mfg. Co., F. A., N. Union at Augusta, Rochester, N. Y.
Speedway Mfg. Co., 1834 S. 52d Ave., (Cicero) Chicago, Ill.
Standard Electrical Products Co., 317 Sibley St., St. Paul, Minn.
Star Electric Motor Co., Bloomfield Ave. & Grove St., Bloomfield, N. J.
Sterling Electric Motors, Inc., Telegraph Rd. at Atlantic Blvd., Los Angeles, Cal.
Sturtevant Co., B. F., Hyde Park, Boston, Mass.
Sundt Engineering Co., 4759 Ravenswood Ave., Chicago, Ill.
Sunlight Electrical Div., General Motors Corp., 523 Dana Ave., Warren, Ohio
U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Cal.
Valley Electric Corp., 4221 Forest Park Blvd., St. Louis, Mo.
Victor Electric Products, Inc., 2950 Robertson Ave., Cincinnati, Ohio
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Warren Telechron Co., 252 Main St., Ashland, Mass.
Wesche Electric Co., B. A., 1628 Vine St., Cincinnati, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MINIATURE MOTORS—see Motors, Fractional Horsepower

PHONOGRAPH MOTORS

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Diehl Mfg. Co., Trumbull & First Sts., Elizabethport, N. J.
Electrical Industries Mfg. Co., Red Bank, N. J.
Emerson Electric Mfg. Co., 1824 Washington Ave., St. Louis, Mo.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
General Electric Co., Schenectady, N. Y.
General Industries Co., 3537 Taylor St., Elyria, Ohio
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
RCA Mfg. Co., Camden, N. J.
Rotor Corp. of America, 10 Norwood St., Dayton, Ohio
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.

Mountings

VIBRATION INSULATING MOUNTINGS

Armstrong Cork Co., 995 Concord St., Lancaster, Pa.
Firestone Tire & Rubber Co., 12 S. Main St., Akron, Ohio
Goodrich Co., B. F., 500 S. Main St., Akron, Ohio
Johns-Manville, 22 E. 40th St., New York, N. Y.
Korfund Co., 48-15 32d Pl., Long Island City, N. Y.
Lord Mfg. Co., 1635 W. 12th St., Erie, Pa.
Vibration Eliminator Co., 25-08 37th Ave., Long Island City, N. Y.

Multipliers

VOLTMETER MULTIPLIERS

Daven Co., 158 Summit St., Newark, N. J.
Farnsworth Television & Radio Corp., Fort Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.

Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

Needles

CUTTING NEEDLES

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Cook, F. L., 606 Parkman Ave., Los Angeles, Cal.
Duotone Co., 799 Broadway, New York, N. Y.
Eldeen Co., 176 W. Wisconsin Ave., Milwaukee, Wis.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electrovox Co., 424 Madison Ave., New York, N. Y.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Federal Recorder Co., Elkhart, Ind.
General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill.
General Phonograph Co., Putnam, Conn.
Gerett Corp., M. A., 2947 N. 30th St., Milwaukee, Wis.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.
Pfanstiehl Chemical Co., 104 Lake View Ave., Waukegan, Ill.
Phonograph Needle Mfg. Co., 42 Dudley St., Providence, R. I.
Piezoelectric Laboratories, 612 Rockland Ave., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Recordisc Corp., 395 Broadway, New York, N. Y.
Recoton Corp., 42 W. 15th St., New York, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Stangard Products Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.
Wilcox-Gay Corp., Charlotte, Mich.

PLAYBACK NEEDLES—see Needles, Playing

PLAYING NEEDLES

Acton Co., H. W., 370 Seventh Ave., New York, N. Y.
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Cook, F. L., 606 Parkman Ave., Los Angeles, Cal.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Duotone Co., 799 Broadway, New York, N. Y.
Eldeen Co., 176 W. Wisconsin Ave., Milwaukee, Wis.
Electrovox Co., 424 Madison Ave., New York, N. Y.
Federal Recorder Co., 50 W. 57th St., New York, N. Y.
Garrard Sales Corp., 296 Broadway, New York, N. Y.
General Phonograph Co., Putnam, Conn.
Gerett Corp., M. A., 2947 N. 30th St., Milwaukee, Wis.
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Lowell Needles Co., 1 Wildore St., Putnam, Conn.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Peerless Album Co., 38 W. 21st St., New York, N. Y.
Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.
Pfanstiehl Chemical Co., 105 Lakeview Ave., Waukegan, Ill.
Phonograph Needle Mfg. Co., 42 Dudley St., Providence, R. I.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Recoton Corp., 42 W. 15th St., New York, N. Y.
Smith, Herman, 180 Lafayette St., New York, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Stangard Products Co., 4111 Ft. Hamilton Pkwy., Brooklyn, N. Y.
Western Sound & Electric Laboratories, 311 W. Kilbourn Ave., Milwaukee, Wis.
Wilcox-Gay Corp., Charlotte, Mich.

RECORDING NEEDLES—see Needles, Cutting

REPRODUCING NEEDLES—see Needles, Playing

Nickel

NICKEL

Apollo Metal Works, 6601 S. Oak Park Ave., Chicago, Ill.
General Plate Div., Metals & Controls Corp., Attleboro, Mass.
Ingersoll Steel & Disc Co., New Castle, Ind.
International Nickel Co., 67 Wall St., New York, N. Y.
(See Advertisement Page 18)
Lukens Steel Co., Coatesville, Pa.
Superior Metal Corp., Clearing, Ill.
Thomas Steel Co., Warren, Ohio

Nuts

MACHINE SCREW NUTS

Arrow Automatic Products Corp., 29 Vestry St., New York, N. Y.
Barnes Co., Div. of Associated Spring Corp., Wallace, Bristol, Conn.
Bayonne Bolt Corp., Humphrey Ave. at Second St., Bayonne, N. J.
Blake & Johnson Co., 1495 Thomaston Ave., Waterville, Conn.
Chicago Screw Co., 1026 S. Homan Ave., Chicago, Ill.
Clark Bros. Bolt Co., Milldale, Conn.
Clendenin Bros., 108 South St., Baltimore, Md.
Cleveland Cap Screw Co., 2917 E. 79th St., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
Corbin Div., American Hardware Corp., P. & F., New Britain, Conn.
Detroit Plating Industries, 1043 Mt. Elliott, Detroit, Mich.
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hartford Machine Screw Co., 476 Capitol Ave., Hartford, Conn.
Haskell Mfg. Co., William H., 22 Commerce St., Pawtucket, R. I.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Line Material Co., 740 N. Second St., Milwaukee, Wis.
Mid-West Screw Products Co., Main & St. George Sts., St. Louis, Mo.
Milton Mfg. Co., Milton, Pa.
New England Screw Co., 44 Farnsworth St., Boston, Mass.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Pittsburgh Screw & Bolt Corp., 2719 Preble Ave., N. S., Pittsburgh, Pa.
Progressive Mfg. Co., 52 Norwood St., Torrington, Conn.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Rhode Island Tool Co., 148 W. River St., Providence, R. I.
Rockford Bolt & Steel Co., 126 Mill St., Rockford, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
St. Louis Screw & Bolt Co., 6900 N. Broadway, St. Louis, Mo.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Tinnerman Products, Inc., 2038 Fulton Rd., Cleveland, Ohio
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
Western Automatic Machine Screw Co., 922 Foster Ave., Elyria, Ohio

SELF LOCKING NUTS

Automatic Nut Co., Lebanon, Pa.
Clark Bros. Bolt Co., Milldale, Conn.
Columbia Nut & Bolt Co., 945 Main St., Bridgeport, Conn.
Drake Lock-Nut Co., 2440 E. 75th St., Cleveland, Ohio
Elastic Stop Nut Corp., 2371 Vauxhall Rd., Union, N. J.
Industrial Lock Nut Co., South Hanover, Mass.
Palnut Co., 62 Cordier St., Irvington, N. J.
Pittsburgh Screw & Bolt Corp., 2719 Preble Ave., N. S., Pittsburgh, Pa.
Security Metal Products, Inc., 345 E. Kalamazoo Ave., Kalamazoo, Mich.
Standard Pressed Steel Co., Jenkintown, Pa.
(See Advertisement Page 126)
Tinnerman Stove & Range Co., Speed Nut Div., 2042 Fulton Rd., Cleveland, Ohio

WING NUTS

Billings & Spencer Co., Laurel & Park Sts., Hartford, Conn.
Chicago Screw Co., 1026 S. Homan Ave., Chicago, Ill.
Clark Bros. Bolt Co., Milldale, Conn.
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hartford Machine Screw Co., 476 Capitol Ave., Hartford, Conn.
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.

Ohmmeters

OHMMETERS

Biddle Co., James G., 1211-13 Arch St., Philadelphia, Pa.
Borden Electric Co., Summit, N. J.
Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
De Jur-Amsco. Corp., Shelton, Conn.
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., (Germantown) Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
Industrial Instrument Co., 2249 14th St., S. W., Akron, Ohio
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Illinois Testing Laboratories, 420 N. La Salle St., Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Martindale Electric Co., 1371 Hird Ave., Cleveland, Ohio
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Radio City Products Co., 88 Park Pl., New York, N. Y.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
(See Advertisement Page 113)
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., 1933 S. Halsted St., Chicago, Ill.

Oscillators

AUDIO-FREQUENCY OSCILLATORS

Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.

Oscillators

AUDIO-FREQUENCY OSCILLATORS (continued)

Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Electronic Products Co., St. Charles, Ill.
Ferris Instrument Co., Boonton, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Hewlett-Packard Co., 481 Page Mill Rd., Palo Alto, Cal.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Leeds & Northrup Co., 4970 Stenton Ave., Cleveland, Ohio
Measurements Corp., Boonton, N. J.
RCA Mfg. Co., Camden, N. J.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.

BEAT FREQUENCY OSCILLATORS —see Oscillators, Audio-Frequency

RADIO-FREQUENCY OSCILLATORS

Audio-Tone Oscillator Co., 60 Walter St., Bridgeport, Conn.
Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Ferris Instrument Corp., Boonton, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works — see Burton-Rogers Co.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
McFarlin Co., 29 W. Marion Ave., Youngs-town, Ohio
Measurements Corp., Boonton, N. J.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Weston Electric Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

TEST OSCILLATORS—see Analyzers, Radio Set

Oscillographs

CATHODE-RAY OSCILLOGRAPHS

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Du Mont Laboratories, Inc., Allen B., 532 Valley Rd., Upper Montclair, N. J. (See Advertisement Page 145)
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Fredericks Co., George E., Bethayres, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Supreme Instruments Corp., Greenwood, Miss.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Cinephone Co., Torrington, Conn.
United Transformer Co., 150 Varick St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOVING-CONDUCTOR OSCILLOGRAPHS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MULTI-ELEMENT OSCILLOGRAPHS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
General Electric Co., Schenectady, N. Y.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

PIEZOELECTRIC OSCILLOGRAPHS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Heiland Research Corp., Club Bldg., Den-ver, Col.
McFarlin Co., 29 W. Marion Ave., Youngs-town, Ohio
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Oscilloscopes

CATHODE-RAY OSCILLOSCOPES

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Du Mont Laboratories, Inc., Allen B., 532 Valley Rd., Upper Montclair, N. J. (See Advertisement Page 145)
Electro-Medical Laboratory, Inc., Hollis-ton, Mass.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Heiland Research Corp., Club Bldg., Den-ver, Col.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
RCA Mfg. Co., Camden, N. J.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Supreme Instrument Corp., Greenwood, Miss.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
United Transformer Co., 150 Varick St., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Ovens

QUARTZ TEMPERATURE CONTROL OVENS

Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Burnett, Wm. W. L., 4814 Idaho St., San Diego, Cal.
General Radio Co., 30 State St., Cambridge, Mass.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Meissner Mfg. Co., Mt. Carmel, Ill.
Precision Piezo Service, 427 Asia St., Baton Rouge, La.
Premier Crystal Laboratories, Inc., 63 Park Row, New York, N. Y.
Western Electric Co.—see Graybar Electric Co.

Phonographs

ELECTRIC PHONOGRAPHS and RECORD PLAYERS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Calvert Motors Associates, Ltd., 1028 Linden Ave., Baltimore, Md.
Chicago Sound Systems Co., 315 E. Grand Ave., Chicago, Ill.
Cinematone Corp., 1107 N. Highland Ave., Hollywood, Cal.
Columbia Recording Corp., 1473 Barnum Ave., Bridgeport, Conn.
Continental Radio & Television Corp., 3800 W. Cortlandt St., Chicago, Ill.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
De Wald Radio Mfg. Corp., 436 Lafayette St., New York, N. Y.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
Dynavox Corp., 55 E. 11th St., New York, N. Y.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Gabel Mfg. Co., John, 1200 W. Lake St., Chicago, Ill.
Garrard Sales Corp., 296 Broadway, New York, N. Y.
Gibbs & Co., Thomas B., 900 W. Lake St., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Herbert Corp., 600 N. Albany, Chicago, Ill.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Majestic Radio & Television Co., 2600 W. 50th St., Chicago, Ill.
Marconiphone, Inc., 679 Madison Ave., New York, N. Y.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Miles Reproducer Co., 812 Broadway, New York, N. Y.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Mills Novelty Co., 4100 Fullerton Ave., Chicago, Ill.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Operadio Mfg. Co., St. Charles, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philharmonic Radio Co., 21 W. 45th St., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Radiad Service, 154 E. Erie St., Chicago, Ill.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Cal.
Rock-Ola Mfg. Corp., 867 N. Kedzie Ave., Chicago, Ill.
Seeburg Corp., J. P., 1510 N. Dayton St., Chicago, Ill.
Silcox Radio & Television Corp., 60 Wall Tower, New York, N. Y.
Sonora Radio & Phonograph Corp., 2626 W. Washington St., Chicago, Ill.
Sonata Phonograph Mfg. Co., 410 E. 32d St., New York, N. Y.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sparks-Withington Co., E. Ganson Ave., Jackson, Mich.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Stangard Products Co., 4111 Ft. Hamil-ton Pkwy., Brooklyn, N. Y.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Talk-A-Phone Mfg. Co., 1219 W. Van Buren St., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Troy Radio & Television Co., 1144 S. Olive St., Los Angeles, Cal.
United Cinephone Corp., Torrington, Conn.
Universal Microphone Co., Inglewood, Cal.

Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.
Waters-Conley Co., 501 First St., N.W., Rochester, Minn.
Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.
Western Electric Co.,—see Graybar Electric Co.
Wurlitzer Mfg. Co., Rudolph, North Tonawanda, N. Y.

Photometers

PHOTO-ELECTRIC PHOTOMETERS —see Meters, Light

Phototubes

see Cells, Photo-Electric

Pickups

PHONOGRAPH PICKUPS

Amperite Corp., 561 Broadway, New York, N. Y.
Astatic Microphone Laboratories, Inc., 830 Market St., Youngstown, Ohio
Audak Co., 500 Fifth Ave., New York, N. Y.
(See Advertisement Page 190)
Audio Devices, Inc., 1600 Broadway, New York, N. Y.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
(See Advertisement Page 86)
Carron Mfg. Co., 415 S. Aberdeen St., Chicago, Ill.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electrical Research Products, Inc., 76 Varick St., New York, N. Y.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Gabel Mfg. Co., John, 1200 W. Lake St., Chicago, Ill.
Garrard Sales Corp., 296 Broadway, New York, N. Y.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Miller Corp., Wm., 362 W. Colorado St., Pasadena, Cal.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Proctor Co., B. A., 230 Park Ave., New York, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
RCA Mfg. Co., Camden, N. J.
Rowe Industries, Inc., 3120 Monroe St., Toledo, Ohio
Shure Bros., 225 W. Huron St., Chicago, Ill.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
United Cinephone Corp., Torrington, Conn.
Universal Microphone Co., Inglewood, Cal.
Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.
Webster Electric Co., Racine, Wis.
(See Advertisement Page 90)
Western Electric Co.—see Graybar Electric Co.

Plants

ELECTRIC POWER PLANTS

Delco Appliance Div., General Motors Sales Corp., 391 Lyell Ave., Rochester, N. Y.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Elcor, Inc., 1060 W. Adams St., Chicago, Ill.
Electric Specialty Co., 211 South St., Stamford, Conn.
Janette Mfg. Co., 558 W. Monroe St., Chicago, Ill.
Kato Engineering Co., 530 N. Front St., Mankato, Minn.
Midco Mfg. & Distributing Co., S. 13th & Kentucky Ave., Sheboygan, Wis.
Onan & Sons, D. W., 43 Royalston Ave., Minneapolis, Minn.
Pioneer Gen-E-Motor Corp., 5849 Dickens Ave., Chicago, Ill.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.

Plastics

MANUFACTURERS of PLASTICS

American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
(See Advertisement Page 79)
Beetle Products Div. of American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y.
Carbide & Carbon Chemicals Corp., 30 E. 42d St., New York, N. Y.
Catalin Corp., 1 Park Ave., New York, N. Y.
Celluloid Corp., 10 E. 40th St., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
du Pont de Nemours & Co., E. I., 626 Schuyler Ave., Arlington, N. J.
Durez Plastics & Chemicals, Inc., Walck Rd., North Tonawanda, N. Y.
Durite Plastics, Div. Stokes & Smith Co., 5010 Summerdale Ave., Philadelphia, Pa.
Fiberloid Corp., Indian Orchard, Mass.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Keasbey & Mattison Co., Butler Ave., Ambler, Pa.
Makalot Corp., 262 Washington St., Boston, Mass.
Monsanto Chemical Co., Plastics Div., Springfield, Mass.
(See Advertisement Page 29)
Plaskon Co., 2112 Sylvan Ave., Toledo, Ohio
Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis, Ind.
Synthane Corp., Oaks, Pa.
(See Advertisement Page 67)
Tennessee Eastman Corp., Kingsport, Tenn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MOLDERS of PLASTICS

Accurate Molding Corp., 116 Nassau St., Brooklyn, N. Y.
Alden Products Co., 715 Center St., Brockton, Mass.
American Insulator Corp., New Freedom, Pa.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Auburn Button Works, Inc., 48 Canoga St., Auburn, N. Y.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Beetle Products Div. of American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y.
Boonton Molding Co., Boonton, N. J.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Breeze Corps., 24 S. Sixth St., Newark, N. J.
Catalin Corp., 1 Park Ave., New York, N. Y.
Celluloid Corp., 180 Madison Ave., New York, N. Y.
Chicago Molded Products Corp., 1029 N. Kolmar Ave., Chicago, Ill.
Cincinnati Moulding Co., 2037 Florence Ave., Cincinnati, Ohio
Cleveland Plastics, Inc., 12910 Taft Ave., Cleveland, Ohio
Colt's Patent Fire Arms Mfg. Co., Plastics Div., Hartford, Conn.
Consolidated Molded Products Corp., 409 Cherry St., Scranton, Pa.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
(See Advertisement Page 11)
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Davies Co., Harry, 1428 N. Wells St., Chicago, Ill.
Dayton Insulating Molding Co., 418 E. First St., Dayton, Ohio
Diemolding Corp., Rasbach St., Canastota, N. Y.
Erie Resistor Corp., Erie, Pa.
(See Advertisement Page 83)
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Garfield Mfg. Co., Garfield, N. J.
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
Gorham Co., Plastics Div., Elmwood Station, Providence, R. I.
Imperial Molded Products Corp., 2925 W. Harrison St., Chicago, Ill.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Insulation Mfg. Co., 11 New York Ave., Brooklyn, N. Y.
Insulation Products Co., Richland St. & Annon Way, Pittsburgh, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Johns-Manville, 22 E. 40th St., New York, N. Y.
Keasbey & Mattison Co., Butler Ave., Ambler, Pa.
Kellogg Switchboard & Supply Co., 1066 W. Adams St., Chicago, Ill.
Keystone Specialty Co., 1372½ Cove Ave., Cleveland, Ohio
Kuhn & Jacob Moulding & Tool Co., 1200 Southard St., Trenton, N. J.
Kurz-Kasch Co., 1415 S. Broadway, Dayton, Ohio
Mack Molding Co., Wayne, N. J.
Molded Insulation Co., 335 E. Price St., Philadelphia, Pa.
Monowatt Electric Corp., 570 Lexington Ave., New York, N. Y.
Niagara Insul-Bake Specialty Co., 483 Delaware Ave., Albany, N. Y.
Northern Industrial Chemical Co., 11 Elkins St., Boston, Mass.
Norton Laboratories, 1025 Mill St., Lockport, N. Y.
Oris Mfg. Co., Thomaston, Conn.
Plastic Molding Corp., Sandy Hook, Conn.
Recto Molded Products, Appleton St. & B. & O. R. R., Cincinnati, Ohio
Remler Co., 2101 Bryant St., San Francisco, Cal.
Reynolds Spring Co., Molded Plastics Div., Reynolds Bldg., Jackson, Mich.
Richardson Co., 27th & Lake Sts., Melrose Park, Ill.
(See Advertisement Page 6)
Royal Moulding Co., 69 Gordon Ave., Providence, R. I.
Siemon Co., State St. & Baum Blvd., Bridgeport, Conn.
Specialty Insulation Mfg. Co., Church St., Hoosick Falls, N. Y.
Stokes Rubber Co., Jos., Taylor & Webster Sts., Trenton, N. J.
Synthane Corp., Oaks, Pa.
(See Advertisement Page 67)
Tech-Art Plastics Co., 41-01 36th Ave., Long Island City, N. Y.
Terkelsen Machine Co., 326 A St., Boston, Mass.
Tingstol Corp., 1461 W. Grand Ave., Chicago, Ill.
Universal Molding Co., 16th & Vermont Sts., San Francisco, Cal.
Waterbury Button Co., 835 S. Main St., Waterbury, Conn.
Watertown Mfg. Co., 3 Porter St., Watertown, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wheeling Stamping Co., Wheeling, W. Va.

Players

RECORD PLAYERS — see Phonographs

Plugs

TERMINAL PLUGS

Alden Products Co., 715 Center St., Brockton, Mass.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Audio Development Co., 1033 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 137)
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Cal.
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 65)
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Electro Motive Mfg. Co., S. Park & John Sts., Willimantic, Conn.
Federal Screw Products Co., 26 S. Jefferson St., Chicago, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
(See Advertisement pages 106, 107)
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
General Radio Co., 30 State St., Cambridge, Mass.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
National Co., 61 Sherman St., Malden, Mass.
Pyle-National Co., 1334 N. Kostner Ave., Chicago, Ill.
Smith, Herman, 180 Lafayette St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Waterbury Button Co., Waterbury, Conn.

Pointers

DIAL POINTERS

American Emblem Co., Utica, N. Y.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Liberty Engraving & Mfg. Co., 2911 S. Central Ave., Los Angeles, Cal.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Radio City Products Co., 88 Park Pl., New York, N. Y.

Points

CONTACT POINTS

American Electro Metal Corp., 320 Yonkers Ave., Yonkers, N. Y.
American Platinum Works, New Jersey R. R. Ave. at Oliver St., Newark, N. J.
Baker & Co., 113 Astor St., Newark, N. J.
Bishop & Co., Platinum Works, J., 12 Channing Ave., Malvern, Pa.
Brainin Co., C. S., 20 Van Dam St., New York, N. Y.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cleveland Tungsten, Inc., 10000 Meech Ave., Cleveland, Ohio
Fansteel Metallurgical Corp., 2200 Sheridan Rd., North Chicago, Ill.
General Electric Co., Schenectady, N. Y.
General Plate Div., Metals & Controls Corp., 34 Forest St., Attleboro, Mass.
General Tungsten Mfg. Co., 502 23d St., Union City, N. J.
Gibson Electric Co., 8350 Frankstown Ave., Pittsburgh, Pa.
Independent Contact Mfg. Co., 540 39th St., Union City, N. J.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Metroloy Co., 57 E. Alpine St., Newark, N. J.
Tungsten Contact Mfg. Co., North Bergen, N. J.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilson Co., H. A., 105 Chestnut St., Newark, N. J.

Porcelain

MOLDERS of PORCELAIN—see **Insulation,** Ceramic

Posts

BINDING POSTS

Alden Products Co., 715 Center St., Brockton, Mass.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cinch Mfg. Corp., 2335 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 65)
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Doran & Sons, James C., 150 Chestnut St., Providence, R. I.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Fahnestock Electric Co., East Ave. & Eighth St., Long Island City, N. Y.
Federal Screw Products Co., 26 S. Jefferson St., Chicago, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
(See Advertisement Pages 106, 107)
General Radio Co., 30 State St., Cambridge, Mass.
Hoosick Falls Radio & Electrical Parts Mfg. Co., First St., Hoosick Falls, N. Y.
Industrial Screw & Supply Co., 711 W. Lake St., Chicago, Ill.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
(See Advertisement Page 124)
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
Meter Devices Co., 1001 Prospect Ave., S. W., Canton, Ohio
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Morse Co., Frank W., 301 Congress St., Boston, Mass.
National Co., 61 Sherman St., Malden, Mass.
Polk, J. L., 139 Maple Ave., Troy, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
States Co., 19 New Park Ave., Hartford, Conn.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.

Potentiometers

POTENTIOMETERS

American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Audio Products Co., 2101 S. Olive St., Burbank, Cal.
Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Coleman Electric Co., 310 Madison St., Maywood, Ill.
Daven Co., 158 Summit St., Newark, N. J.
Dickson Co., 7420 Woodlawn Ave., Chicago, Ill.
Electronic Products Co., St. Charles, Ill.
Foxboro Co., Neponset Ave., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Hellige, Inc., 3718 Northern Blvd., Long Island City, N. Y.
J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Lewis Engineering Co., Naugatuck, Conn.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Spence Engineering Co., 53 Grant St., Walden, N. Y.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Taylor Instrument Companies, 100 Ames St., Rochester, N. Y.
Thwing-Albert Instrument Co., 3395 Lancaster Ave., Philadelphia, Pa.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
United Cinephone Corp., Torrington, Conn.
Utah Radio Products Co., 820 N. Orleans St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.

Pumps

VACUUM PUMPS

Adel Precision Products Corp., Burbank, Cal.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Beach-Russ Co., 50 Church St., New York, N. Y.
Buffalo Foundry & Machine Co., 1635 Fillmore Ave., Buffalo, N. Y.
Columbus Steam Pump Works Co., Columbus, Ohio
Distillation Products, Inc., 755 Ridge Rd., W., Rochester, N. Y.
Gardner-Denver Co., 100 Williamson St., Quincy, Ill.
General Electric Co., Schenectady, N. Y.
Gerotor Mfg. Co., Maryland Ave. & Oliver St., Baltimore, Md.
Ingersoll-Rand Co., 11 Broadway, New York, N. Y.
International Machine Works, North Bergen, N. J.
Kahle Engineering Corp., 1307 Seventh St., North Bergen, N. J.
Kinney Mfg. Co., 3529 Washington St., Boston, Mass.
Kraissl Co., 303 Williams Ave., Hackensack, N. J.
Leiman Bros., 156 Christie St., Newark, N. J.
New Jersey Machine Corp., 1800 Willow Ave., Hoboken, N. J.
Nichols & Sons, W. H., 303 Woerd Ave., Waltham, Mass.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Robbins & Myers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Stokes Machine Co., F. J., 5850 Tabor Rd., Olney P. O., Philadelphia, Pa.
Sullivan Machinery Co., 929 Woodland Ave., Michigan City, Ind.
Worthington Pump & Machinery Corp., Harrison, N. J.
Yeomans Bros. Co., 1459 N. Dayton St., Chicago, Ill.
Zenith Products Co., West Newton, Mass.

"Q"-Meters

"Q"- METERS

Boonton Radio Corp., Boonton, N. J.

Receivers

AIRCRAFT RECEIVERS

Aircraft Radio Corp., Boonton, N. J.
Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Air Radio & Instrument Co., 5214 W. 63d St., Chicago, Ill.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hallicrafters, Inc., 2611 S. Indiana St., Chicago, Ill.
(See Advertisement Page 81)
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Harvey-Wells Communications, Inc., Southbridge, Mass.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
International Telephone Development Co., 137 Varick St., New York, N. Y.
Karadio Corp., 2323 Chestnut St., Oakland, Cal.
Lear Aviation, Inc., Dayton Municipal Airport, Dayton, Ohio
Marine Radio Corp., 119 168th St., Jamaica, N. Y.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
National Co., 61 Sherman St., Malden, Mass.
Radio Frequency Laboratories, Inc., Boonton, N. J.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Selectar Mfg. Corp., 30 W. 15th St., New York, N. Y.
Smith Co., Maxwell, 1027 N. Highland Ave., Kearny, N. J.
Sparks-Withington Co., North St., Jackson, Mich.
Taylor Airphone Products, Inc., Municipal Airport, Long Beach, Cal.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

AMATEUR RECEIVERS

Echophone Radio Co., 201 E. 26th St., Chicago, Ill.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Hallicrafters, Inc., 2611 S. Indiana St., Chicago, Ill.
(See Advertisement Page 81)
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Marine Radio Corp., 119 168th St., Jamaica, N. Y.
Meissner Mfg. Co., Mt. Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.

National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Pierson-De Lane, Inc., 2345 W. Washington Blvd., Los Angeles, Cal.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Mfg. Engineers, Inc., 111 Harrison St., Peoria, Ill.
Radio Transceiver Laboratories, 120-03 Jamaica Ave., Richmond Hill N. Y.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Sargent Co., E. H., 212 Ninth St., Oakland, Cal.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Tefft Radio Co., Plymouth, Mich.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

AUTO RECEIVERS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Automatic Radio & Television Co., 122 Brookline Ave., Boston, Mass.
Bell Radio & Television, 125 E. 46th St., New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Calvert Motors Associates, Ltd., 1028 Linden Ave., Baltimore, Md.
Cavalier Motors Associates, Ltd., 1028 Linden Ave., Baltimore, Md.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Crosley Corp., 1329 Arlington St., Cincinnati, Ohio
Delco Radio Div., General Motors Service, Kokomo, Ind.
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
De Wald Radio Mfg. Corp., 436 Lafayette St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Karadio Corp., 2323 Chestnut St., Oakland, Cal.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Radio Products Corp., 3800 W. Cortland St., Chicago, Ill.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Silicox Radio & Television Corp., 60 Wall Tower, New York, N. Y.
Sonora Radio & Phonograph Corp., 2926 W. Washington St., Chicago, Ill.
Stewart-Warner Corp., 1826 Diversey Pkwy., Chicago, Ill.
Trav-ler Karenola Tele Corp., 1036 W. Van Buren St., Chicago, Ill.
Trebor Radio Co., Pasadena, Cal.
Troy Radio & Television Co., 1144 S. Olive St., Los Angeles, Cal.
Universal Battery Co., 3410 S. La Salle St., Chicago, Ill.
Warwick Mfg. Co., 1700 W. Washington Blvd., Chicago, Ill.
Wells-Gardner & Co., 2701 N. Kildare Ave., Chicago, Ill.
Western Auto Supply Co., 2107 Grand Ave., Kansas City, Mo.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

FACSIMILE RECEIVERS — **see Transmitters, Facsimile**

FREQUENCY MODULATION RECEIVERS

Air King Products Co., 1523 63d St., Brooklyn, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Communications Measurements Lab., 136 Liberty St., New York, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 39 W. 19 St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hallicrafters Co., 2131 Indiana Ave., Chicago, Ill.
(See Advertisement Page 81)
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Meissner Mfg. Co., Mt. Carmel, Ill.
National Co., 61 Sherman St., Malden, Mass.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Philharmonic Radio Co., 21 W. 45th St., New York, N. Y.
Pierson-De Lane, Inc., 2345 W. Washington Blvd., Los Angeles, Cal.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Scott Labs Inc., E. H., 4450 Ravenswood Ave., Chicago, Ill.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Stewart-Warner Corp., 1826 Diversey Pkwy, Chicago, Ill.
Stromberg-Carlson Telephone Mfg., 100 Carlson Rd., Rochester, N. Y.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

HOME RECEIVERS

Air King Products Co., 1523 63d St., Brooklyn, N. Y.
Andrea Radio Corp., 4820 48th Ave., Woodside, N. Y.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Autocrat Radio Co., 3855 N. Hamilton Ave., Chicago, Ill.
Automatic Radio & Television Co., 122 Brookline Ave., Boston, Mass.
Bell Radio & Television, 125 E. 46th St., New York, N. Y.
Belmont Radio Corp., 1257 Fullerton Ave., Chicago, Ill.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Brunswick Radio Div., Mersman Bros. Corp., 206 Lexington Ave., New York, N. Y.
Calvert Motors Associates, Ltd., 1028 Linden Ave., Baltimore, Md.
Canton Trading Co., 135 Liberty St., New York, N. Y.
Colonial Radio Corp., 254 Rano St., Buffalo, N. Y.
Continental Radio & Television Corp., 3800 W. Cortlandt St., Chicago, Ill.
Crosley Corp., 1329 Arlington St., Cincinnati, Ohio
Delco Radio Div., General Motors Service, Kokomo, Ind.
De Wald Radio Mfg. Corp., 436 Lafayette St., New York, N. Y.
Electrical Research Labo, Inc., 2020 Ridge Ave., Evanston, Ill.
Electromatic Distributors, Inc., 88 University Pl., New York, N. Y.
Emerson Radio & Phonograph Corp., 111 Eighth Ave., New York, N. Y.
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Fada Radio & Electric Co., 30-20 Thomson Ave., Long Island City, N. Y.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
Freed Radio Corp., 39 W. 19th St., New York, N. Y.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Garod Radio Corp., 70 Washington St., Brooklyn, N. Y.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
General Television & Radio Corp., 1240 N. Homan Ave., Chicago, Ill.
Gilfillan Bros., Inc., 1815 Venice Blvd., Los Angeles, Cal.
Grebe Mfg. Co., 70 Washington St., Brooklyn, N. Y.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Kadette Radio Corp., 310 First National Bldg., Ann Arbor, Mich.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Laurehk Radio Mfg. Co., 3918 Monroe Ave., Wayne, Mich.
L'Tatro Mfg. Co., 417 W. Water St., Decorah, Iowa
Magnavox Co., 2131 Bueter Rd., Fort Wayne, Ind.
Majestic Radio & Television Co., 3600 W. 50th St., Chicago, Ill.
Marconiphone, Inc., 679 Madison Ave., New York, N. Y.
Meissner Mfg. Co., Mt. Carmel, Ill.
Midwest Radio Corp., 909 Broadway, Cincinnati, Ohio
Mitchell Mfg. Co., 1550 N. Dayton St., Chicago, Ill.
National Union Radio Corp., 57 State St., Newark, N. J.
Noblitt-Sparks Industries, E. 17th St., Columbus, Ind.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Packard Bell Co., 1320 S. Grand Ave., Los Angeles, Cal.
Paramount Radio Corp., 967 22d St., Oakland, Cal.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Philmore Mfg. Co., 113 University Pl., New York, N. Y.
Pilot Radio Corp., 37-06 36th St., Long Island City, N. Y.
Radio Products Corp., 3800 W. Cortland St., Chicago, Ill.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Recordovox, Inc., 80 Cortlandt St., New York, N. Y.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Scott Labs Inc., E. H., 4450 Ravenswood Ave., Chicago, Ill.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Silicox Radio & Television Co., 60 Wall Tower, New York, N. Y.
Sky Chief Radio Corp., 345 E. 27th St., New York, N. Y.
Sonora Radio & Phonograph Corp., 2926 W. Washington St., Chicago, Ill.
Sparks-Withington Co., Jackson, Mich.
Stewart-Warner Corp., 1826 Diversey Pkwy, Chicago, Ill.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Trav-ler Karenola Tele Corp., 1036 W. Van Buren St., Chicago, Ill.
Trebor Radio Co., Pasadena, Cal.
Troy Radio & Television Co., 1144 S. Olive St., Los Angeles, Cal.
Universal Battery Co., 3410 S. La Salle St., Chicago, Ill.
Walsh, Lincoln, 34 DeHart Pl., Elizabeth, N. J.
Warwick Mfg. Co., 1700 W. Washington Blvd., Chicago, Ill.
Watterson Radio Mfg. Co., 2608 Ross Ave., Dallas, Tex.
Western Auto Supply Co., 2107 Grand Ave., Kansas City, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilcox-Gay Corp., Charlotte, Mich.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.
Zepher Radio Co., 13139 Hamilton Ave., Detroit, Mich.

MARINE RECEIVERS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
American Communications Corp., 123 Liberty St., New York, N. Y.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Espey Mfg. Co., 305 E. 63d St., New York, N. Y.
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
(See Advertisement Page 81)
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Harvey-Wells Communications, Inc., Southbridge, Mass.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
International Telephone Development Co., 137 Varick St., New York, N. Y.
Jefferson, Inc., Ray, 182 Millburn Ave., Baldwin, N. Y.
Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Karadio Corp., 2323 Chestnut St., Oakland, Cal.
Karns-White Corp., 1775 Broadway, New York, N. Y.
Marine Radio Corp., 119 168th St., Jamaica, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Radiomarine Corp. of America, 75 Varick St., New York, N. Y.
Sargent Co., E. H., 219 9th St., Oakland, Cal.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Televiso Prods. Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.

Receivers

MARINE RECEIVERS (continued)

Wilcox Electric Co., 40th & State Line, Kansas City, Mo.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

POLICE RECEIVERS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
American Communications Corp., 123 Liberty St., New York, N. Y.
Bassett Radio Mfg. Corp., Niles, Mich.
Bee Engineering Co., 7665 Grand River Ave., Detroit, Mich.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Detrola Corp., 1501 Beard Ave., Detroit, Mich.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Harvey-Wells Communications, Inc., Southbridge, Mass.
Howard Radio Co., 1731 Belmont Ave., Chicago, Ill.
Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Karadio Corp., 2323 Chestnut St., Oakland, Cal.
Link, Fred M., 125 W. 17th St., New York, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Pierson-De Lane, Inc., 2345 W. Washington Blvd., Los Angeles, Cal.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
RCA Mfg. Co., Camden, N. J.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co., 300 Central Ave., Kearny, N. J.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RADIO COMPASS RECEIVERS

Aeronautical Radio Co., Roosevelt Field, Mineola, N. Y.
Airguide, Inc., Islip, N. Y.
Air Radio & Instrument Co., 5214 W. 63d St., Chicago, Ill.
Aircraft Accessories Corp., 166 W. Olive Ave., Burbank, Cal.
Airplane & Marine Direction Finder Corp., Clearfield, Pa.
American Aircraft Radio Div., Searle Aero Industries, Inc., 226 N. Hawthorne Blvd., Hawthorne, Cal.
Ansley Radio Corp., 21-10 49th Ave., Long Island City, N. Y.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Fisher Research Laboratory, 1961 University Ave., Palo Alto, Cal.
Frazar & Co., 301 Clay St., San Francisco, Cal.
Gray Radio Co., 730 Okeeshobee Rd., West Palm Beach, Fla.
Harvey Radio Laboratories, Inc., 447 Concord Ave., Cambridge, Mass.
International Telephone Development Co., 137 Varick St., New York, N. Y.
Jefferson, Inc., Ray, 182 Millburn Ave., Baldwin, N. Y.
Lear Avia, Inc., Dayton Municipal Airport, Dayton, Ohio
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Panoramic Radio Corp., 298 Broadway, New York, N. Y.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J.,
Sargent Co., E. H., 219 Ninth St., Oakland, Cal.
Siebenthaler Div., Aircraft Accessories Corp., Kansas City, Mo.
Stratosearch, Inc., Westchester Airport, Armonk, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

Recorders

CONDENSER LEAKAGE RECORDERS

Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.

ILLUMINATION RECORDERS—see **Meters,** Light

NOISE RECORDERS

Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
General Radio Co., 30 State St., Cambridge, Mass.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.

SOUND RECORDERS—see **Heads,** Cutting

also **Machines,** Recording

Records

PHONOGRAPH RECORDS

Clark Phonograph Record Co., 216 High St., Newark, N. J.
Columbia Recording Corp., 1475 Barnum Ave., Bridgeport, Conn.
Decca Records, Inc., 50 W. 57th St., New York, N. Y.
Jack Mfg. Corp., Charles, 420 Lehigh St., Allentown, Pa.
Musicraft Records, Inc., 242 W. 55th St., New York, N. Y.
Pan-American Record Co., 705 First St., Louisville, Ky.
Poinsettia, Inc., 95 Cedar Ave., Pitman, N. J.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Ralston Record Co., 112 Cedar Ave., Pitman, N. J.
Rangertone, Inc., 201 Verona Ave., Newark, N. J.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Rieber, Inc., Frank, 11916 W. Pico Blvd., Los Angeles, Cal.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.

Rectifiers

DRY DISC RECTIFIERS

American Communications Corp., 123 Liberty St., New York, N. Y.
American Television & Radio Corp., 300 E. 4th St., St. Paul, Minn.
Benwood Linze Co., 1805 Locust St., St. Louis, Mo.
(See Advertisement Page 128)
Electrical Products Co., 6535 Russell St., Detroit, Mich.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., West Lynn, Mass.
International Telephone Development Co., 137 Varick St., New York, N. Y.
(See Advertisement Page 4)
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Standard Transformer, 1500 N. Halstead St., Chicago, Ill.

FULL-WAVE RECTIFIERS — see **Tubes,** Receiving

HALF-WAVE RECTIFIERS — see **Tubes,** Receiving

POWER RECTIFIERS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Communications Corp., 123 Liberty St., New York, N. Y.
American Television & Radio Corp., 300 E. 4th St., St. Paul, Minn.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Bee Engineering Co., 7665 Grand River Ave., Detroit, Mich.
Benwood Linze Co., 1805 Locust St., St. Louis, Mo.
(See Advertisement Page 128)
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Electronic Laboratories, Inc., 122 W. New York St., Indianapolis, Ind.
Electronic Products Co., St. Charles, Ill.
Electro Products Laboratories, 549 W. Randolph St., Chicago, Ill.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
Ferris Instrument Corp., Boonton, N. J.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Gibbs & Co., Thomas B., 900 W. Lake St., Chicago, Ill.
Green Electric Co., W., 130 Cedar St., New York, N. Y.
Hadley, Robert M., 711 E. 61st St., Los Angeles, Cal.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Mellaphone Corp., 65 Atlantic Ave., Rochester, N. Y.
National Co., 61 Sherman St., Malden, Mass.
New York Transformer Co., 480 Lexington Ave., New York, N. Y.
Radiart Corp., W. 62d St. & Barberton Ave., Cleveland, Ohio
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Raytheon Mfg. Co., Waltham, Mass.
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Standard Transformer, 1500 N. Halsted St., Chicago, Ill.
Taylor Tubes, Inc., 2341 Wabansia Ave., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
United Motors Service, 3044 W. Grand Blvd., Detroit, Mich.
United Transformer Corp., 150 Varick St., New York, N. Y.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

TUBE RECTIFIERS—see **Tubes,** Rectifiers

Regulators

AUTOMATIC REGULATORS

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Amperite Corp., 561 Broadway, New York, N. Y.
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52nd St., New York, N. Y.
Burlington Instrument Corp., Burlington, Iowa
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Robertshaw Thermostat Co., Youngwood, Pa.
Roller-Smith Co., Bethlehem, Pa.

VOLTAGE REGULATORS

see also Transformers, Voltage Regulating

Acme Electric & Mfg. Co., 16 Water St., Cuba, N. Y.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Transformer Co., 178 Emmet St., Newark, N. J.
Amperite Corp., 561 Broadway, New York, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
Burlington Instrument Corp., Burlington, Iowa
Clark Controller Co., 1146 E. 152d St., Cleveland, Ohio
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.

Eclipse Aviation Div. of Bendix Aviation Corp., Bendix, N. J.
Electronic Products Co., St. Charles, Ill.
Ferris Instrument Corp., Boonton, N. J.
Fredericks Co., George E., Bethayres, Pa.
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Marine Radio Corp., 117-19 168th St., Jamaica, N. Y.
Miller Co., Bertrand F., Trenton, N. J.
Norwalk Transformer Corp., South Norwalk, Conn.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Superior Electric Co., 32 Harrison St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
United Cinephone Corp., Torrington, Conn.
United Transformer Corp., 150 Varick St., New York, N. Y.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Wirt Co., 5221 Green St., Philadelphia, Pa.

Relays

AUTOMATIC RELAYS—see Relays, Electromagnetic

CAPACITY OPERATED RELAYS

Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Luxtrol Co., 54 W. 21st St., New York, N. Y.

CIRCUIT CONTROL RELAYS—see Relays, Electromagnetic

CONTINUOUS CURRENT RELAYS —see Relays, Electromagnetic

ELECTROMAGNETIC RELAYS

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
(See Advertisement Page 123)
Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Allied Control Co., 227 Fulton St., New York, N. Y.
(See Advertisement Page 132)
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 118)
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Autocall Co., Shelby, Ohio
(See Advertisement Page 147)
Automatic Electric Mfg. Co., 729 S. Front St., Mankato, Minn.
Automatic Switch Co., 41 E. 11th St., New York, N. Y.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Bunnell & Co., J. H., 215 Fulton St., New York, N. Y.
Burling Instrument Co., 241 Springfield Ave., Newark, N. J.
Clare & Co., C. P., Lawrence & Lamon Ave., Chicago, Ill.
Cramer & Co., R. W., Centerbrook, Conn.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Eclipse Aviation Div. of Bendix Aviation Corp., Bendix, N. J.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
Fenwal, Inc., Main St., Ashland, Mass.
Friez & Sons, Julien P., 4 N. Central Ave., Baltimore, Md.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., Schenectady, N. Y.
Gleason-Avery, Inc., 27 Clark St., Auburn, N. Y.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
(See Advertisement Page 115)
Guardian Electric Mfg. Co., 1620 W. Walnut St., Chicago, Ill.
(See Advertisement Page 76)
Hagan Corp., George J., 2400 E. Carson St., Pittsburgh, Pa.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
H-B Instrument Co., 2520 N. Broad St., Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Industrial Engineering Corp., Evansville, Ind.
Industrial Engineering Equipment Co., 323 E. Fourth St., Davenport, Iowa
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Lumenite Elec. Co., Old Colony Bldg., Chicago, Ill.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Miller Co., Bertrand F., P. O. Box 455, Trenton, N. J.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Penn Electric Switch Co., Goshen, Ind.
Perfex Corp., 415 W. Oklahoma Pl., Milwaukee, Wis.
Philadelphia Thermometer Co., 917 Filbert St., Philadelphia, Pa.
Photobell Corp., 123 Liberty St., New York, N. Y.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
R. B. M. Mfg. Co., Div. Essex Wire Corp., Logansport, Ind.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Sigma Instruments, Inc., 78 Freeport St., Boston, Mass.
(See Advertisement Page 125)
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
(See Advertisement Page 135)
Superior Electric Co., 32 Harrison St., Bristol, Conn.
(See Advertisement Page 137)
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
United Cinephone Corp., Torrington, Conn.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

FREQUENCY RELAYS—see Relays, Electromagnetic

GALVANOMETER RELAYS—see Relays, Electromagnetic

HEAVY DUTY RELAYS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Allied Control Co., 227 Fulton St., New York, N. Y.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Autocall Co., Shelby, Ohio
Automatic Switch Co., 41 E. 11th St., New York, N. Y.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., Schenectady, N. Y.
Hagan Corp., George J., 2400 E. Carson St., Pittsburgh, Pa.
H-B Instrument Co., 2520 N. Broad St., Philadelphia, Pa.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
(See Advertisement Page 78)
Miller Co., Bertrand F., Trenton, N. J.
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Penn Electric Switch Co., Goshen, Ind.
Philadelphia Thermometer Co., 917 Filbert St., Philadelphia, Pa.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

INSTRUMENT CONTROLLED RELAYS—see Relays, Electromagnetic

MERCURY RELAYS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Autocall Co., Shelby, Ohio
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Continental Electric Co., Geneva, Ill.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
General Controls Co., 801 Allen Ave., Glendale, Cal.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Guardian Electric Mfg. Co., 1620 W. Walnut St., Chicago, Ill.
H-B Electric Co., 2520 N. Broad St., Philadelphia, Pa.
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Philadelphia Thermometer Co., 917 Filbert St., Philadelphia, Pa.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
(See Advertisement Page 135)
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

MOTOR DRIVEN TIME DELAY RELAYS—see Relays, Time Delay

MOVABLE COIL A. C. RELAYS—see Relays, Electromagnetic

OVERLOAD RELAYS—see Breakers, Circuit

PERMANENT MAGNET MOVABLE COIL RELAYS—see Relays, Electromagnetic

PHOTOELECTRIC RELAYS

see also Controls, Industrial Electronic

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
Allied Control Co., 227 Fulton St., New York, N. Y.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Continental Electric Co., Geneva, Ill.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Dickson Co., 7420 Woodlawn Ave., Chicago, Ill.
Eby, Inc., Hugh H., 4700 Stenton Ave., Philadelphia, Pa.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Electronic Products Co., 605 Prairie St., St. Charles, Ill.
Ess Instrument Co., 31 Irving Pl., New York, N. Y.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Electric Co., Schenectady, N. Y.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.

Relays

PHOTOELECTRIC RELAYS (continued)

Lipman Eng. Co., 415 Van Braam St., Pittsburgh, Pa.
Lumenite Electric Co., Old Colony Bldg., Chicago, Ill.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Photobell Corp., 123 Liberty St., New York, N. Y.
Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Rehtron Corp., 2159 Magnolia Ave., Chicago, Ill.
Sigma Instruments, Inc., 78 Freeport St., Boston, Mass.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
United Cinephone Corp., Torrington, Conn.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

POLARIZED RELAYS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Autocall Co., Shelby, Ohio
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
L A B Corp., Summit, N. J.
Milier Co., Bertrand F., Trenton, N. J.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

POWER RELAYS—see Relays, Heavy Duty

RESISTANCE D. C. RELAYS—see Relays, Electromagnetic

STEPPING RELAYS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Autocall Co., Shelby, Ohio
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Guardian Electric Mfg. Co., 1620-27 W. Walnut St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.

TELEPHONE RELAYS

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Autocall Co., Shelby, Ohio
Clare & Co., C. P., Lawrence & Lamon Aves., Chicago, Ill.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Kurman Electric Co., 241 Lafayette St., New York, N. Y.
Leach Relay Co., 5915 Avalon Blvd., Los Angeles, Cal.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.

TEMPERATURE RELAYS — see Relays, Electromagnetic

THERMAL TIME DELAY RELAYS —see Relays, Time Delay

TIME DELAY RELAYS

Advance Electric Co., 1260 W. Second St., Los Angeles, Cal.
Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
American Gas Accumulator Co., Electrical Div., Elizabeth, N. J.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Autocall Co., Shelby, Ohio
Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
(See Advertisement Page 116)
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
(See Advertisement Page 87)
Durakool, Inc., 1010 N. Main St., Elkhart, Ind.
Eagle Signal Corp., Moline, Ill.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
Electronic Products Co., St. Charles, Ill.
Friez & Son, Julien P., 4 N. Central Ave., Baltimore, Md.
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1620-27 W. Walnut St., Chicago, Ill.
Industrial Engineering Equipment Co., 323 E. Fourth St., Davenport, Iowa
Luxtrol Co., Inc., 54 W. 21st St., New York, N. Y.
Magnetic Gauge Co., 60 E. Bartges St., Akron, Ohio
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Perfex Corp., 415 W. Oklahoma Pl., Milwaukee, Wis.
Photobell Corp., 123 Liberty St., New York, N. Y.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Preferred Utilities Mfg. Corp., 31 West 60th St., New York, N. Y.
Southwestern Electronics Labs., 2326 Guadalupe St., Austin, Tex.
Spencer Thermostat Co., 34 Forest St., Attleboro, Mass.
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
(See Advertisement Page 135)
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
White-Rodgers Electric Co., 1209 Cass Ave., St. Louis, Mo.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

TRANSFORMER RELAYS — see Relays, Electromagnetic

VACUUM CONTACT RELAYS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.

Resistors

CARBON COMPRESSION RESISTORS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Eastern Specialty Co., 3617 N. 8th St., Philadelphia, Pa.
Electro Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie Pa.
(See Advertisement Page 83)
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 89)
Le Carbone, Inc., Myrtle Ave., Boonton, N. J.
National Carbon Co., 30 E. 42 St., New York, N. Y.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Speer Carbon Co., St. Marys, Pa.
Stackpole Carbon Co., Tannery St., St. Marys, Pa.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Wirt Co., 5221 Green St., Philadelphia, Pa.

DECADE RESISTORS

Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
(See Advertisement Page 92)
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
(See Advertisement Page 113)
Supreme Instruments Corp., 414 Howard St., Greenwood, Miss.
Tech Laboratories, 7 Lincoln St., Jersey City, N. J.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
United Transformer Corp., 150 Varick St., New York, N. Y.

DUMMY ANTENNA RESISTORS

Ohmite Mfg. Co., 4835 W. Flournoy St., Chicago, Ill.

FIXED RESISTORS

Acme Electric Heating Co., 1217 Washington St., Boston, Mass.
Aerovox Corp., New Bedford, Mass.
Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
(See Advertisement Page 75)
Clark Controller Co., 1146 E. 152d St., Cleveland, Ohio
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
(See Advertisement Page 145)
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Daven Co., 158 Summit St., Newark, N. J.
Dixon Crucible Co., Joseph, Monmouth St., Jersey City, N. J.
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Electrad, Inc., 175 Varick St., New York, N. Y.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
Electro-Motive Mfg. Co., Willimantic, Conn.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
(See Advertisement Page 83)
Euclid Electric & Mfg. Co., Chardon Rd., Euclid, Ohio
General Electric Co., Schenectady, N. Y.
Globar Div. Carborundum Co., Hyde Park Blvd., Niagara Falls, N. Y.
(See Advertisement Page 121)
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 89)
Monitor Controller Co., 51 S. Gay St., Baltimore, Md.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
(See Advertisement Page 92)
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Rex Rheostat Co., 37 W. 20th St., New York, N. Y.
Schaefer Bros. Co., 1059 W. 11th St., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Speer Carbon Co., St. Marys, Pa.
Sprague Specialties Co., North Adams, Mass.
Square D Co., 6060 Rivard St., Detroit, Mich.
Stackpole Carbon Co., St. Mary's Pa.
(See Advertisement Page 103)
States Co., 3 New Park Ave., Hartford, Conn.
Tuttle & Co., H. W., 261 W. Maumee St., Adrian, Mich.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
White Dental Mfg. Co., S. S. (Industrial Div.), 10 E. 40th St., New York, N. Y.
Wirt Co., 5221 Greene St. (Germantown), Philadelphia, Pa.

HIGH FREQUENCY RESISTORS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Daven Co., 158 Summit St., Newark, N. J.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
General Radio Co., 30 State St., Cambridge, Mass.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)

Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
(See Advertisement Page 12)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 30)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Measurements Corp., Boonton, N. J.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
(See Advertisement Page 92)
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.

HIGH VOLTAGE RESISTORS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
(See Advertisement Page 145)
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
(See Advertisement Page 12)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 30)
J B L Instrument Co., Darby, Pa.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
(See Advertisement Page 92)
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.

PRECISION RESISTORS

Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Daven Co., 158 Summit St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., (Germantown) Philadelphia, Pa.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 30)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Meter Devices Co., 1001 Prospect Ave., S. W., Canton, Ohio
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

STANDARD RESISTORS—see **Standards,** Resistance

VARIABLE RESISTORS and RHEOSTATS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Instrument Co., 8010 Georgia Ave., Silver Spring, Md.
Atlas Resistor Co., 423 Broome St., New York, N. Y.
Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Centralab, 900 E. Keefe Ave., Milwaukee, Wis.
(See Advertisement Page 75)
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
Chicago Telephone Supply Co., 1142 W. Beardsley Ave., Elkhart, Ind.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Clarostat Mfg. Co., 285 N. 6th St., Brooklyn, N. Y.
(See Advertisement Page 145)
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Gray Instrument Co., 64½ W. Johnson St., Philadelphia, Pa.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
(See Advertisement Page 12)
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 30)
Lectrohm, Inc., 5133 W. 25th Pl. (Cicero) Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Electric Controller Co., 5305 Ravenswood Ave., Chicago, Ill.
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
(See Advertisement Page 92)
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Rex Rheostat Co., 37 W. 20th St., New York, N. Y.
(See Advertisement Page 149)
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Stackpole Carbon Co., Tannery St., St. Marys, Pa.
(See Advertisement Page 103)
Tilton Electric Corp., 15 E. 26th St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

WIRE WOUND RESISTORS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
Clarostat Mfg. Co., 287 N. Sixth St., Brooklyn, N. Y.
(See Advertisement Page 145)
Continental Carbon, Inc., 13900 Lorain Ave., Cleveland, Ohio
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Daven Co., 158 Summit St., Newark, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Gray Instrument Co., 64 W. Johnson St., (Germantown) Philadelphia, Pa.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
(See Advertisement Page 12)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
(See Advertisement Page 30)
Lectrohm, Inc., 5133 W. 25th Pl., (Cicero) Chicago, Ill.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Micamold Radio Corp., 1087 Flushing Ave., Brooklyn, N. Y.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
Ohio Carbon Co., 12508 Berea Rd., Cleveland, Ohio
Ohmite Mfg. Co., 4818 W. Flournoy St., Chicago, Ill.
(See Advertisement Page 92)
Rex Rheostat Co., 37 W. 20th St., New York, N. Y.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
White Dental Mfg. Co., S. S., 10 E. 40th St., New York, N. Y.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

Rheostats

LABORATORY RHEOSTATS — see **Resistors,** Variable

METER TESTING RHEOSTATS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
De Jur-Amsco Corp., Shelton, Conn.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
States Co., 19 New Park Ave., Hartford, Conn.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
(See Advertisement Page 72)
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

SLIDE WIRE RHEOSTATS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.
Chicago Apparatus Co., 1735 N. Ashland Ave., Chicago, Ill.
General Radio Co., 30 State St., Cambridge, Mass.
G-M Laboratories, Inc., 4326 N. Knox Ave., Chicago, Ill.
Hardwick, Hindle, Inc., 40 Hermon St., Newark, N. J.
(See Advertisement Page 84)
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
National Electric Controller Co., 5307 Ravenswood Ave., Chicago, Ill.
Rex Rheostat Co., 37 W. 20th St., New York, N. Y.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
(See Advertisement Page 72)

Rivets

RIVETS

American Brass Co., Waterbury, Conn.
Atlas Tack Corp., Pleasant St., Fairhaven, Mass.
Blake & Johnson Co., 1495 Thomaston Ave., Waterville, Conn.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Chicago Rivet & Machine Co., 1830 S. 54th Ave., (Cicero) Chicago, Ill.
Clark Bros. Bolt Co., Milldale, Conn.
Clendenin Bros., 108 South St., Baltimore, Md.
Cobb & Drew, Kingston St., Plymouth, Mass.
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hassal, Inc., John, Clay & Oakland Sts., Brooklyn, N. Y.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Manufacturer's Belt Hook Co., 1321 W. Congress St., Chicago, Ill.
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
Milton Mfg. Co., Milton, Pa.
New England Screw Co., 44 Farnsworth St., Boston, Mass.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Pittsburgh Screw & Bolt Corp., 2719 Preble Ave., N. S., Pittsburgh, Pa.
Plume & Atwood Mfg. Co., 470 Bank St., Waterbury, Conn.
Progressive Mfg. Co., 52 Norwood St., Torrington, Conn.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Rockford Bolt & Steel Co., 126 Mill St., Rockford, Ill.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Tubular Rivet & Stud Co., Wollaston, Mass.

Scales

DIAL SCALES

American Emblem Co., Utica, N. Y.
Austin Co., O., 42 Greene St., New York, N. Y.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio

Scales

DIAL SCALES (Continued)

Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Crowe Name Plate & Mfg. Co., 3701 Ravenswood Ave., Chicago, Ill.
Erie Resistor Corp., 644 W. 12th St., Erie, Pa.
Gemloid Corp., 79-10 Albion Ave., Elmhurst, N. Y.
Grammes & Sons, Inc., L. F., 366 Union St., Allentown, Pa.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Parisian Novelty Co., 3510 S. Western Ave., Chicago, Ill.
Premier Crystal Laboratories, Inc., 55 Park Row, New York, N. Y.

Schools

RADIO and TELEVISION TRAINING SCHOOLS

American School, Drexel Ave. at 58th St., Chicago, Ill.
Capitol Radio Engineering Institute, Inc., 3224 16th St., N. W., Washington, D. C.
Dodge Institute, Valparaiso, Ind.
Massachusetts Radio School, 18 Boylston St., Boston, Mass.
Midland Television, Inc., Power & Light Bldg., Kansas City, Mo.
National Schools, 4000 Figueroa St., Los Angeles, Cal.
National Radio Institute, 16th & U Sts., Washington, D. C.
Pacific Radio Institute, 1355 Market St., San Francisco, Cal.
Port Arthur Radio College, Port Arthur, Tex.
Radio Television Institute, Inc., 480 Lexington Ave., New York, N. Y.
Radio Training Association of America, 4525 Ravenswood Ave., Chicago, Ill.
RCA Institute, Inc., 75 Varick St., New York, N. Y.
Sprayberry Academy of Radio, 2548 University Pl., N. W., Washington, D. C.
Universal Television System, 2107 Grand Ave., Kansas City, Mo.

Screens

X-RAY FLUOROSCOPIC SCREENS

General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Kelley-Koett Mfg. Co., Covington, Ky.
Patterson Screen Co., Towanda, Pa.
Westinghouse X-Ray Co., 21-16 43d Ave., Long Island City, N. Y.

Screwdrivers

SCREWDRIVERS and SMALL INSULATED TOOLS

Bridgeport Hardware Mfg. Corp., Iranistan Ave., Bridgeport, Conn.
Crescent Tool Co., 200 Harrison St., Jamestown, N. Y.
Eastern Specialty Co., 3617-19 N. Eighth St., Philadelphia, Pa.
Forsberg Mfg. Co., 125 Seaview Ave., Bridgeport, Conn.
Hoosick Falls Radio & Electrical Parts Mfg. Co., First St., Hoosick Falls, N. Y.
Park Metalware Co., Orchard Park, N. Y. (See Advertisement Page 112)
Schollhorn Co., William, 414 Chapel St., New Haven, Conn.
Stanley Tools, Div. of Stanley Works, New Britain, Conn.
Utica Drop Forge & Tool Corp., 2800 Whitesboro St., Utica, N. Y.

Screws

MACHINE SCREWS

American Screw Co., 21 Stevens St., Providence, R. I.
Atlas Bolt & Screw Co., 1144 Ivanhoe Rd., Cleveland, Ohio
Blake & Johnson Co., 1495 Thomaston Ave., Waterville, Conn.
Central Screw Co., 3511 Shields Ave., Chicago, Ill.
Chandler Products Corp., 1475 Chardon Rd., Cleveland, Ohio
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Clark Bros. Bolt Co., Milldale, Conn.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Eagle Lock Co., Terryville, Conn.
Economy Screw Corp., 2717 Greenview Ave., Chicago, Ill.
Elco Tool & Screw Corp., 1818 Broadway, Rockford, Ill.
Ferry Screw Products, Inc., E. W., 8219 Almira Ave., Cleveland, Ohio
General Mfg. Co., Waterbury, Conn.
Hassall, Inc., John, Clay & Oakland Sts., Brooklyn, N. Y.
Hubbell, Inc., Harvey, State St. & Bostwick Ave., Bridgeport, Conn.
International Screw Co., 9446 Roselawn Ave., Detroit, Mich.
Keystone Bolt & Nut Co., 9507 Meech Ave., Cleveland, Ohio
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
National Lock Co., Rockford, Ill.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio
New England Screw Co., Keene, N. H.
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pawtucket Screw Co., 141 Hughes Ave., Pawtucket, R. I.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Progressive Mfg. Co., 52 Norwood St., Torrington, Conn.
Reading Screw Co., Norristown, Pa.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Remington Screw & Bolt Mfg. Co., Cold Spring-on-Hudson, N. Y.
Rockford Screw Products Co., 2541 Ninth St., Rockford, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
St. Louis Screw & Bolt Co., 6900 N. Broadway, St. Louis, Mo.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Sterling Bolt Co., 707 W. Van Buren St., Chicago, Ill.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
Wasmer Bolt & Screw Corp., 13000 Athens Ave., Cleveland, Ohio
Western Automatic Machine Screw Co., 922 Foster Ave., Elyria, Ohio

RECESSED HEAD SCREWS

American Screw Co., 21 Stevens St., Providence, R. I.
Central Screw Co., Chicago, Ill. (See Advertisement Page 31)
Chandler Products Co., Cleveland, Ohio (See Advertisement Page 31)
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
International Screw Co., Detroit, Mich. (See Advertisement Page 31)
Lamson & Sessions Co., Cleveland, Ohio (See Advertisement Page 31)
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio
New England Screw Co., Keene, N. H. (See Advertisement Page 31)
Parker Co., Chas., Meriden, Conn. (See Advertisement Page 31)
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pawtucket Screw Co., Pawtucket, R. I. (See Advertisement Page 31)
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
Southington Hardware Co., Southington, Conn.
Scovill Mfg. Co., Waterbury, Conn. (See Advertisement Page 51)
Shakeproof Lock Washer Co., Chicago, Ill. (See Advertisement Page 51)
Whitney Screw Co., Nashua, N. H. (See Advertisement Page 31)

SELF TAPPING SCREWS

American Screw Co., 21 Stevens St., Providence, R. I.
Central Screw Co., 3511 Shields Ave., Chicago, Ill.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Rhode Island Tool Co., 148 W. River St., Providence, R. I.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.

SET and CAP SCREWS

Acme Machine Products Co., Muncie, Ind.
Allen Mfg. Co., 129 Sheldon St., Hartford, Conn.
Allied Products Corp., 4646 Lawton Ave., Detroit, Mich.
Atlas Bolt & Screw Co., 1144 Ivanhoe Rd., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Chandler Products Corp., 1475 Chardon Rd., Cleveland, Ohio
Chicago Screw Co., 1026 S. Homan Ave., Chicago, Ill.
Clark Bros. Bolt Co., Milldale, Conn.
Cleveland Cap Screw Co., 2917 E. 79th St., Cleveland, Ohio
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Dardelet Threadlock Corp., 55 Liberty St., New York, N. Y.
Elco Tool & Screw Corp., 1818 Broadway, Rockford, Ill.
Federal Screw Works, 3401 Martin St., Detroit, Mich.
Ferry Cap & Set Screw Co., Scranton & North Rds., Cleveland, Ohio
Ferry Screw Products, Inc., E. W., 8219 Almira Ave., Cleveland, Ohio
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hartford Machine Screw Co., 476 Capitol Ave., Hartford, Conn.
Haskell Mfg. Co., William H., 22 Commerce St., Pawtucket, R. I.
Holo-Krome Screw Corp., 11 Brooks St., Hartford, Conn.
Keystone Bolt & Nut Co., 9507 Meech Ave., Cleveland, Ohio
Lamson & Sessions Co., 1971 W. 85th St., Cleveland, Ohio
Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis, Minn.
Mac-It Parts Co., Lancaster, Pa.
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
Mid-West Screw Products Co., Main & St. George Sts., St. Louis, Mo.
Monarch Cap Screw & Mfg. Co., 5906 Park Ave., Cleveland, Ohio
Moore, George W., 44 Farnsworth St., Boston, Mass.
National Acme Co., E. 131st & Chapin Sts., Cleveland, Ohio
National Lock Co., Rockford, Ill.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio
Ottemiller Co., Wm. H., York, Pa.
Parker-Kalon Corp., 200 Varick St., New York, N. Y.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Remington Screw & Bolt Mfg. Co., Cold Spring-on-Hudson, N. Y.
Republic Steel Corp., Upson Nut Div., Cleveland, Ohio
Rhode Island Tool Co., 148 W. River St., Providence, R. I.
Rochester Machine Screw Co., 171 Clarissa St., Rochester, N. Y.
Rockford Bolt & Steel Co., 126 Mill St., Rockford, Ill.
Rockford Screw Products Co., 2541 Ninth St., Rockford, Ill.
Russell, Burdsall & Ward Bolt & Nut Co., Midland Ave., Port Chester, N. Y.
St. Louis Screw & Bolt Co., 6900 N. Broadway, St. Louis, Mo.
Sandusky Nut Co., Sandusky, Ohio
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Shimer & Sons, Samuel J., Milton, Pa.
Standard Pressed Steel Co., Jenkintown, Pa.
Sterling Bolt Co., 707 W. Van Buren St., Chicago, Ill.
Triplex Screw Co., 5317 Grant Ave., Cleveland, Ohio
Union Screw & Mfg. Co., 207 S. Main St., Pittsburgh, Pa.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
Wasmer Bolt & Screw Corp., 13000 Athens Ave., Cleveland, Ohio
Western Automatic Machine Screw Co., 922 Foster Ave., Elyria, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WOOD SCREWS

American Screw Co., 21 Stevens St., Providence, R. I.
Atlantic Screw Works, Inc., Hartford, Conn.
Continental Screw Co., New Bedford, Mass.
Corbin Screw Corp., New Britain, Conn.
Eagle Lock Co., Terryville, Conn.
Elco Tool & Screw Corp., 1818 Broadway, Rockford, Ill.
Ferry Screw Products, Inc., E. W., 8219 Almira Ave., Cleveland, Ohio
Keeler Brass Co., Webb & Bek Sts., Grand Rapids, Mich.
Keystone Bolt & Nut Co., 9507 Meech Ave., Cleveland, Ohio
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
National Lock Co., Rockford, Ill.
National Screw & Mfg. Co., 2440 E. 75th St., Cleveland, Ohio

Parker Co., Charles, 48 Elm St., Meriden, Conn.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Reading Screw Co., Norristown, Pa.
Reed & Prince Mfg. Co., Duncan Ave., Worcester, Mass.
Remington Screw & Bolt Mfg. Co., Cold Spring-on-Hudson, N. Y.
Rockford Screw Products Co., 2541 Ninth St., Rockford, Ill.
Southington Hardware Co., Southington, Conn.
Sterling Bolt Co., 707 W. Van Buren St., Chicago, Ill.
Weber-Knapp Co., 1939 Chadakoin St., Jamestown, N. Y.
Whitney Screw Corp., Nashua, N. H.

Sets

CORD and PLUG SETS—see Cords, Radio and Appliance

INSULATION TESTING SETS

Acme Electric & Mfg. Co., 16 Water St., Cuba, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Electric Service Supplies Co., 17th & Cambria Sts., Philadelphia, Pa.
General Radio Co., 30 State St., Cambridge, Mass.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Industrial Transformer Corp., 2540 Belmont Ave., New York, N. Y.
J B L Instrument Co., Darby, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Miller Co., Bertrand F., Trenton, N. J.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Standard Transformer Co., 140 Dana St., N.E., Warren, Ohio
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Shafts

FLEXIBLE SHAFTS

Albertson & Co., 3100 Floyd Ave., Sioux City, Iowa
Breeze Corps., 24 S. Sixth St., Newark, N. J.
Chicago Flexible Shaft Co., 5600 Roosevelt Rd., Chicago, Ill.
Coates Clipper & Mfg. Co., 237 Chandler St., Worcester, Mass.
Fischer Spring Co., Chas., 248 Kent Ave., Brooklyn, N. Y.
Haskins Co., R. G., 615 S. California St., Chicago, Ill.
Jarvis Co., Charles L., Middletown, Conn.
Linick, Green & Reed, 55 E. Washington St., Chicago, Ill.
Mall Tool Co., 7740 S. Chicago Ave., Chicago, Ill.
Martindale Electric Co., 1371 Hird Ave., Cleveland, Ohio
Pratt & Whitney Div., Niles-Bement-Pond Co., Charter Oak Blvd., Hartford, Conn.
Stewart Mfg. Corp., F. M., 4311 Ravenswood Ave., Chicago, Ill.
Stow Mfg. Co., 445 State St., Binghamton, N. Y.
Strand & Co., N. A., 5001 N. Wolcott Ave., Chicago, Ill.
Swartz & White Mfg. Co., 215 Washington St., Binghamton, N. Y.
United States Electrical Tool Co., 2490 Riverside Drive, Cincinnati, Ohio
Walker-Turner Co., Plainfield, N. J.
White Dental Mfg. Co., S. S. (Industrial Div.), 10 E. 40th St., New York, N. Y.
(See Advertisement Page 129)
Wyzenbeck & Staff, 838 W. Hubbard St., Chicago, Ill.

Shields

TUBE SHIELDS

American Radio Hardware Co., 476 Broadway, New York, N. Y.
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
Bond Products Co., 13139 Hamilton Ave., Detroit, Mich.
Bud Radio, Inc., 5205 Cedar Ave., Cleveland, Ohio
Ellis & Sons, Inc., George D., 309 N. Third St., Philadelphia, Pa.
Erie Can Co., 816 Erie St., Chicago, Ill.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
(See Advertisement Page 122)
Guthman & Co, Edwin I., 100 S. Peoria St., Chicago, Ill.
Hegeler Zinc Co., Danville, Ill.
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 N. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Paul & Beekman, 4250 Wissahickon Ave., Philadelphia, Pa.

Shunts

AMMETER SHUNTS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Gray Instrument Co., 64 W. Johnson St. (Germantown), Philadelphia, Pa.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Roller-Smith Co., Bethlehem, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Sockets

VACUUM TUBE SOCKETS

Alden Products Co., 715 Center St., Brockton, Mass.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
American Radio Hardware Co., 476 Broadway, New York, N. Y.
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Bond Products Co., 13139 Hamilton Ave., Detroit Mich.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Cal.
Cinch Mfg. Co., 2335 W. Van Buren St., Chicago, Ill.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Eagle Electric Mfg. Co., 59 Hall St., Brooklyn, N. Y.
Eby, Inc., H. H., 4700 Stenton Ave., Philadelphia, Pa.
Federal Screw Products Co., 26 S. Jefferson St., Chicago, Ill.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
(See Advertisement Pages 106, 107)
General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.
General Radio Co., 30 State St., Cambridge, Mass.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
Johnson Co., E. F., Waseca, Minn.
Jones, Howard B., 2300 Wabansia Ave., Chicago, Ill.
Kellogg Switchboard & Supply Co., 6650 S. Cicero Ave., Chicago, Ill.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Micarta Fabricators, Inc., 4619 Ravenswood Ave., Chicago, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Remler Co., 2101 Bryant St., San Francisco, Cal.
Smith, Herman, 180 Lafayette St., New York, N. Y.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Synthane Corp., River Rd., Oaks, Pa.

DIAL LIGHT SOCKETS

Lenz Electric Co., 1751 No. Western Ave., Chicago, Ill.
(See Advertisement Page 10)

Solder

SOLDER

Allen Co., L. B., 6730 Bryn Mawr Ave., Chicago, Ill.
Alpha Metal & Rolling Mills, Inc., 363 Hudson Ave., Brooklyn, N. Y.
Belmont Smelting & Refining Works, Inc., 323 Belmont Ave., Brooklyn, N. Y.
Brach Mfg. Corp., L. S., 55 Dickerson St., Newark, N. J.
Division Lead Co., 836 W. Kinzie St., Chicago, Ill.
Dunton Co., M. W., 670 Eddy St., Providence, R. I.
Gardiner Metal Co., 4820 S. Campbell Ave., Chicago, Ill.
Glaser Lead Co., 31 Wyckoff Ave., Brooklyn, N. Y.
Heck Metal Co., 318 N. Holliday St., Baltimore, Md.
Kester Solder Co., 4212 Wrightwood Ave., Chicago, Ill.
(See Advertisement Page 88)
Lenk Mfg. Co., Newton Lower Falls, Mass.
National Lead Co., 111 Broadway, New York, N. Y.
New York Solder Co., 15 Crosby St., New York, N. Y.
Paramount Wire Co., 98 Bleecker St., New York, N. Y.
Ruby Chemical Co., 63 McDowell St., Columbus, Ohio

Speakers

see Loudspeakers

Springs

SPRINGS

Accurate Spring Mfg. Co., 3817 W. Lake St., Chicago, Ill.
American Coil Spring Co., 2034 Keating Ave., Muskegon, Mich.
American Spiral Spring & Mfg. Co., 5528 Harrison St., Pittsburgh, Pa.
American Spring & Wire Specialty Co., 816 N. Spaulding St., Chicago, Ill.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Barnes Co., Wallace, Div. of Associated Spring Corp., Bristol, Conn.
Cary Spring Works, Inc., 240 W. 29th St., New York, N. Y.
Cleveland Wire Spring Co., Cuyahoga Heights, Cleveland, Ohio
Cuyahoga Spring Co., 10272 Berea Rd., Cleveland, Ohio
Dunbar Bros. Co., Div. of Associated Spring Corp., 76 South St., Bristol, Conn.
Gardner Wire Co., 5045 W. Lake St., Chicago, Ill.
Gibson Co., Wm. D., Div. of Associated Spring Corp., 1800 Claybourn Ave., Chicago, Ill.
Hubbard Spring Co., M. D., 672 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
(See Advertisement Page 140)
Instrument Specialties Co., 244 Bergen Blvd., Little Falls, N. J.
Jones Spring Co., W. B., 124 E. Seventh St., Cincinnati, Ohio
Lee Spring Co., 30 Main St., Brooklyn, N. Y.
Manross & Sons, F. N., Div. of Associated Spring Corp., Forestville, Conn.
Peck Spring Co., Plainville, Conn.
Phoenix Hardware Mfg. Co., 49 Illinois St., Buffalo, N. Y.
Raymond Mfg. Co., Div. of Associated Spring Corp., Corry, Pa.
Reliance Spring & Mfg. Co., 238 40th St., Brooklyn, N. Y.
Reynolds Spring Co., 955 Water St., Jackson, Mich.
Tuck Mfg. Co., Brockton, Mass.
Union Spring & Mfg. Co., New Kensington, Pa.
Wickwire Spencer Steel Co., 500 Fifth Ave., New York, N. Y.
Yost Superior Co., Springfield, Ohio

Stabilizers

VOLTAGE STABILIZERS—see Regulators, Voltage

Stampings

METAL STAMPINGS

Accurate Spring Mfg. Co., 3817 W. Lake St., Chicago, Ill.
Acklin Stamping Co., 1925 Nebraska Ave., Toledo, Ohio
Acme Stamping & Mfg. Co., 200 Corliss St., Pittsburgh, Pa.
Ainsworth Mfg. Co., 2200 Franklin St., Detroit, Mich.
Akron-Selle Co., Chestnut St., Akron, Ohio
Allegheny-Ludlum Steel Corp., Oliver Bldg., Pittsburg, Pa.
Aluminum Goods Mfg. Co., 15th & Franklin Sts., Manitowoc, Wis.
American Brass Co., Waterbury, Conn.
American Emblem Co., Utica, N. Y.
American Pulley Co., 4260 Wissahickon Ave., Philadelphia, Pa.
American Stamping Co., 1000 E. 64th St., Cleveland, Ohio
Ansonia Mfg. Co., Ansonia, Conn.
Auburn Mfg. Co., Middletown, Conn.
Barnes Co., Div. of Associated Spring Corp., Wallace, Bristol, Conn.
Barnes-Gibson-Raymond Div. of Associated Spring Corp., 6400 Miller Ave., Detroit, Mich.
Bay State Stamping Co., 380 Chandler St., Worcester, Mass.
Berger Mfg. Co., Canton, Ohio
Bettcher Mfg. Co., 3106 W. 61st St., Cleveland, Ohio
Bowen Products Corp., Auburn, N. Y.
Brewer-Titchner Corp., Cortland, N. Y.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
Bridgeport Chain & Mfg. Co., 962 Crescent Ave., Bridgeport, Conn.
Briggs Mfg. Co., 11631 Mack Ave., Detroit, Mich.
Budd Mfg. Co., Edward G., 25th & Hunting Park Ave., Philadelphia, Pa.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Continental Machines, Inc., 1308 South Washington Ave., Minneapolis, Minn.
Crescent Industries, 4140 W. Belmont Ave., Chicago, Ill.
Crosby Co., 183 Pratt St., Buffalo, N. Y.
Dahlstrom Metallic Door Co., Jamestown, N. Y.
Defiance Pressed Steel Co., Defiance, Ohio
Detroit Stamping Co., 3461 W. Fort St., Detroit, Mich.
Dickey-Grabler Co., 10302 Madison Ave., Cleveland, Ohio
Dunbar Bros. Co., 76 South St., Bristol, Conn.
Edwards Mfg. Co., 529 Eggleston Ave., Cincinnati, Ohio
Erie Art Metal Co., 1602 E. 18th St., Erie, Pa.
Faries Mfg. Co., 1036 E. Grand Ave., Decatur, Ill.
Forsyth Metal Goods Co., Aurora, Ill.
Fostoria Pressed Steel Co., Fostoria, Ohio
Franklin Fibre-Lamitex Corp., Wilmington, Del.
Franklin Mfg. Corp., A. W., 175 Varick St., New York, N. Y.
Fulton Sylphon Co., 2300 Cumberland Ave., Knoxville, Tenn.
General Industries Co., Cleveland and Olive Sts., Elyria, Ohio
General Metal Products Co., 3879 Delor St., St. Louis, Mo.
Geometric Stamping Co., 1111 E. 200th St., Cleveland, Ohio
Gibson Co., Div. of Associated Spring Corp., Wm. D., 1800 Clybourn Ave., Chicago, Ill.
Glenvale Products Corp., 9316 French Rd., Detroit, Mich.
Goat Metal Stampings, Inc., 314 Dean St., Brooklyn, N. Y.
Goetze Gasket & Packing Co., New Brunswick, N. J.
Grabler Mfg. Co., 6565 Broadway, S.E., Cleveland, Ohio
Grammes & Sons, L. F., 344 Union St., Allentown, Pa.
Gregory Mfg. Co., (Mt. Carmel) New Haven, Conn.
Greist Mfg. Co., 501 Blake St., New Haven, Conn.
Hoosier Lamp & Stamping Corp., Evansville, Ind.
Hubbard Spring Co., M. D., 672 Central Ave., Pontiac, Mich.
Hunter Pressed Steel Co., Lansdale, Pa.
Industrial Engineering & Mfg. Co., 239 John St., Bridgeport, Conn.
International Insulating Div., General Industries Co., Cleveland and Olive Sts., Elyria, Ohio
King Laboratories, Inc., 205 Oneida St., Syracuse, N. Y.
Laminated Shim Co., 21-26 44th Ave., Long Island City, N. Y.
Lansing Stamping Co., 1159 Pennsylvania Ave., Lansing, Mich.
Manganese Steel Forge Co., Allen St. and Castor Ave., Philadelphia, Pa.
Master Products Co., 6414 Park Ave., Cleveland, Ohio
McCord Radiator & Mfg. Co., 2587 E. Grand Ave., Detroit, Mich.
Melrath Supply & Gasket Co., Tioga & Memphis Sts., Philadelphia, Pa.
Midland Steel Products Co., 10600 Madison Ave., Cleveland, Ohio
Milwaukee Stamping Co., 802 S. 72d St., Milwaukee, Wis.
National Brass Co., 1599 Madison Ave., Grand Rapids, Mich.
National Motor Bearing Co., 1100 78th Ave., Oakland, Cal.
National Stamping Co., 630 St. Jean St., Detroit, Mich.
New Products Corp., Benton Harbor, Mich.
Parish Pressed Steel Co., Robinson & Neiser Sts., Reading, Pa.
Patton-Mac Guyer Co., Baker St. & Virginia Ave., Providence, R. I.
Peck Spring Co., Plainville, Conn.
Pheoll Mfg. Co., 5700 Roosevelt Rd., Chicago, Ill.
Plume & Atwood Mfg. Co., 470 Bank St., Waterbury, Conn.
Powell Pressed Steel Co., Hubbard, Ohio
Prentice Mfg. Co., G. E., New Britain Ave., New Britain, Conn.
Pressed Steel Co., Wilkes-Barre, Pa.
Raymond Mfg. Co., Div. of Associated Spring Corp., Corry, Pa.
Reliable Spring Co., 3167 Fulton Rd., Cleveland, Ohio
Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Rockwood Sprinkler Co., 50 Harlow St., Worcester, Mass.
Saginaw Stamping & Tool Co., Saginaw, Mich.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Sessions & Sons, J. H., Bristol, Conn.
Sheet Metal Specialty Co., Third & Liberty, Pittsburgh, Pa.
Standard Pressed Steel Co., Jenkintown, Pa.
Stanley Works, New Britain, Conn.
Steel & Tubes, Inc., 250 E. 131st St., Cleveland, Ohio
Stimpson Co., Edwin B., 74 Franklin Ave., Brooklyn, N. Y.
Swanson Machine Co., Jamestown, N. Y.
Thomas & Skinner Steel Products Co., 1120 E. 23d St., Indianapolis, Ind.
(See Advertisement Page 143)
Titchener & Co., E. H., Binghamton, N. Y.
Torrington Mfg. Co., 70 Franklin St., Torrington, Conn.
Transue & Williams Steel Forging Corp., 562 W. Ely St., Alliance, Ohio
Truscon Steel Co., Pressed Steel Div., 6100 Truscon Ave., Cleveland, Ohio
Union Spring & Mfg. Co., New Kensington, Pa.
United Carr Fastener Corp., Cambridge, Mass.
United Screw & Bolt Corp., 2513 W. Cullerton St., Chicago, Ill.
U. S. Indestructible Gasket Co., 829 E. 15 St., Brooklyn, N. Y.
Veeder-Root, Inc., 63 Sargeant St., Hartford, Conn.
Victor Mfg. & Gasket Co., 5750 W. Roosevelt Rd., Chicago, Ill.
Waterbury Button Co., Waterbury, Conn.
Western Cartridge Co., East Alton, Ill.
Whitehead Stamping Co., 1661 W. Lafayette Blvd., Detroit, Mich.
Wilcox, Crittenden & Co., Middletown, Conn.
Worcester Pressed Steel Co., 100 Barker Ave., Worcester, Mass.
Wrought Washer Mfg. Co., 2223 S. Bay St., Milwaukee, Wis.
Youngstown Pressed Steel Co., Warren, Ohio

Standards

CAPACITANCE STANDARDS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Solar Mfg. Corp., 586 Avenue A, Bayonne, N. J.

FREQUENCY STANDARDS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Browning Laboratories, Inc., 750 Main St., Winchester, Mass.
Ferris Instrument Corp., Boonton, N. J.
General Radio Co., 30 State St., Cambridge, Mass.
Millen Mfg. Co., Inc., James, 150 Exchange St., Malden, Mass.
(See Advertisement Page 141)

INDUCTANCE STANDARDS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.

RESISTANCE STANDARDS

Beck Bros., 421 Sedgley Ave., Philadelphia, Pa.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Daven Co., 158 Summit St., Newark, N. J.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Instrument Resistors, Inc., 25 Amity St., Little Falls, N. J.
International Resistance Co., 401 N. Broad St., Philadelphia, Pa.
Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
(See Advertisement Page 113)
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.

Stands

MICROPHONE STANDS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Microphone Co., 1915 S. Western Ave., Los Angeles, Cal.
Amperite Co., 561 Broadway, New York, N. Y.
Art Specialty Co., 1115 N. Franklin St., Chicago, Ill.
Astatic Microphone Laboratory, 830 Market St., Youngstown, Ohio
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Bell Sound Systems, Inc, 1183 Essex Ave., Columbus, Ohio
Braun, Inc, W. C., 601 W. Randolph St., Chicago, Ill.
Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal
Eastern Mike-Stand Co., 56 Christopher Ave., Brooklyn, N. Y.
Electrical Sound Engineering Co., 5303 Kenilworth Ave., Baltimore, Md.
Electro-Voice Mfg. Co., 1239 South Bend Ave., South Bend, Ind.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Lektra Labs, Inc., 30 E. 10th St., New York, N. Y.
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
National-Dobro Corp., 400 S. Peoria St., Chicago, Ill.
Operadio Mfg. Co., 13th and Indiana Sts., St. Charles, Ill.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
RCA Mfg. Co., Camden, N. J.
Shure Bros., 225 W. Huron St., Chicago, Ill.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Turner Co., Cedar Rapids, Iowa
Universal Microphone Co., Centinela at Inglewood, Cal.
Webster Electric Co., De Koven Ave. and Clark St., Racine, Wis.
Western Electric Co., 300 Central Ave., Kearny, N. J.

SPEAKER STANDS

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Art Specialty Co., 1115 N. Franklin St., Chicago, Ill.
Atlas Sound Corp, 1451 39th St., Brooklyn, N. Y.

Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Lifetime Corp., 1825 Adams St., Toledo, Ohio
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Laboratories, 1617 N. Damen St., Chicago, Ill.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
University Laboratories, 195 Chrystie St., New York, N. Y.

Steel

ELECTRICAL STEEL

Allegheny-Ludlum Steel Corp., Oliver Bldg., Pittsburgh, Pa.
American Rolling Mill Co., Curtis St., Middletown, Ohio
Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh, Pa.
Empire Sheet & Tin Plate Co., N. Bowman St., Mansfield, Ohio
Follansbee Steel Corp., Third & Liberty Sts., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Newport Rolling Mill Co., Ninth & Lowell Sts., Newport, Ky.
Republic Steel Corp., Alloy Steel Div., Massillon, Ohio
Swedish Iron & Steel Corp., 17 Battery Pl., New York, N. Y.
Union Drawn Steel Div., Republic Steel Corp., Harsh Ave., S. E., Massillon, Ohio
Wheeling Steel Corp., Wheeling Steel Corp. Bldg., Wheeling, W. Va.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown, Ohio

Strips

TERMINAL STRIPS—see Posts, Binding

Stroboscopes

STROBOSCOPES

Boulin Instrument Corp., 65 Madison Ave., New York, N. Y.
Commercial Engineering Laboratories, 4612 Woodward Ave., Detroit, Mich.
General Radio Co., 30 State St., Cambridge, Mass.
L. A. B. Corp., Summit, N. J.
Pioneer Instrument Div. of Bendix Aviation, Bendix, N. J.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zeiss, Inc., Carl, 485 Fifth Ave., New York, N. Y.

Stylii

CUTTING STYLII—see Needles, Cutting

Switches

PUSH BUTTON SWITCHES—see Switches, Snap

RELAY SWITCHES—see Relays, Electromagnetic

ROTARY and BAND CHANGE SWITCHES

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Autocall Co., Shelby, Ohio
Cannon Electric Development Co., 3209 Humboldt St., Los Angeles, Cal.
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Furnas Electric Co., Batavia, Ill.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Lewis Engineering Co., 52 Rubber Ave., Naugatuck, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
Meissner Mfg. Co., Mt. Carmel, Ill.
New England Radiocrafters, 1156 Commonwealth Ave., Brookline, Mass.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
(See Advertisement Page 113)
Tagliabue Mfg. Co., C. J., Park & Nostrand Ave., Brooklyn, N. Y.
Thwing-Albert Instrument Co., 3323 Lancaster Ave., Philadelphia, Pa.
Triplett Electrical Instrument Co., 135 E. College Ave., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

SNAP SWITCHES

Arrow-Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford, Conn.
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hart Mfg. Co., 110 Bartholomew Ave., Hartford, Conn.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind.
McDonnell & Miller, Wrigley Bldg., Chicago, Ill.
Micro Switch Corp., Spring St., Freeport, Ill.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Mu-Switch Corp., Washington St., Canton, Mass.
Perfex Corp., 415 W. Oklahoma Pl., Milwaukee, Wis.
Stackpole Carbon Co., Tannery St., St. Mary's, Pa.
(See Advertisement Page 103)
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Wirt Co., 5221 Greene St., Philadelphia, Pa.

TIME SWITCHES

American Timer Corp., Geneva, Ill.
Anderson Mfg. Co., Albert & J. M., 305 A St., Boston, Mass.
Autocall Co., Shelby, Ohio
Automatic Electric Mfg. Co., 729 S. Front St., Mankato, Minn.
Bacon, Emra D., 4513 Brooklyn Ave., Cleveland, Ohio
Cleveland Time Clock & Service Co., Superior Ave. at E. 27th St., Cleveland, Ohio
Cramer Co., R. W., Centerbrook, Conn.
Eagle Signal Corp., Moline, Ill.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
Electric Controls Corp., 68 Murray St., New York, N. Y.
Frober-Faybor Co., Chagrin Falls, Ohio
General Electric Co., Schenectady, N. Y.
Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago, Ill.
Industrial Engineering Corp., Evansville, Ind.
Industrial Instrument Co., 2249 14th St., S.W., Akron, Ohio
Mercoid Corp., 4201 Belmont Ave., Chicago, Ill.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Northwestern Clock Co., Brown Bldg., Omaha, Neb.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Perfex Corp., 415 W. Oklahoma Pl., Milwaukee, Wis.
Reliance Automatic Lighting Co., 1931 Mead St., Racine, Wis.
Rhodes, Inc., M. H., 30 Bartholomew Ave., Hartford, Conn.
Sangamo Electric Co., Springfield, Ill.
South Bend Current Controller Co., 2038 River Pk., South Bend, Ind.
States Co., 19 New Park Ave., Hartford, Conn.
Swartzbaugh Mfg. Co., 1336 W. Bancroft St., Toledo, Ohio
Thomas Clocks, Seth, Div. General Time Instruments Corp., S. Main St., Thomaston, Conn.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Tork Clock Co., 31 South St., Mount Vernon, N. Y.
Wadsworth Electric Mfg. Co., 20 W. 11th St., Covington, Ky.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

TOGGLE SWITCHES—see Switches, Snap

Systems

COMPLETE SOUND SYSTEMS

Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Communications Corp., 123 Liberty St., New York, N. Y.
American Television Corp., 130 W. 56th St., New York, N. Y.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arrow Radio Co., 900 W. Jackson Blvd., Chicago, Ill.
Atlas Sound Corp., 1451 39th St., Brooklyn, N. Y.
Audiograph Sound Systems, 1313 W. Randolph St., Chicago, Ill.
Autocall Co., Shelby, Ohio
Bank's Mfg. Co., 5019 N. Winthrop Ave., Chicago, Ill.
Bell Sound Systems, Inc., 1183 Essex Ave., Columbus, Ohio
Bogen Co., David, 663 Broadway, New York, N. Y.
Braun, Inc., W. C., 601 W. Randolph St., Chicago, Ill.
Chicago Sound Systems Co., 315 E. Grand Ave., Chicago, Ill.
Cinema Engineering Co., 1508 W. Verdugo Ave., Burbank, Cal.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Empire Radio Mfg. Co., 114 E. 47th St., New York, N. Y.
Erwood Sound Equipment Co., 223 W. Erie St., Chicago, Ill.
Fulton Radio Corp., 100 6th Ave., New York, N. Y.
Gates Companies, Quincy, Ill
General Communication Products Co., Lexington Ave. at Vine, Hollywood, Cal.
Gibbs & Co., 900 W. Lake St., Chicago, Ill.
Jack Mfg. Corp., Charles, 420 Lehigh St., Allentown, Pa.
Lafayette Radio Corp., 100 Sixth Ave., New York, N. Y.
Laurehk Radio Mfg. Co., 3918 Monroe Ave., Wayne, Mich.
Lincrophone Co., 1661 Howard Ave., Utica, N. Y.
Marine Radio Corp., 117–19 168th St., Jamaica, N. Y.
Meck Industries, John, 1313 W. Randolph St., Chicago, Ill.
Million Radio & Television Labs., 1617 N. Damen Ave., Chicago, Ill.
Morlen Electric Co., 60 W. 15th St., New York, N. Y.
Operadio Mfg. Co., 13th & Indiana Sts., St. Charles, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Presto Recording Corp., 242 W. 55th St., New York, N. Y.
Racon Electric Co., 52 E. 19th St., New York, N. Y.
Radiad Service, 154 E. Erie St., Chicago, Ill.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
Rauland Corp., 3333 Belmont Ave., Chicago, Ill.
(See Advertisement Page 128)
Ray-Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17 St., New York, N. Y.
Setchell-Carlson, Inc., 2233 University Ave., St. Paul, Minn.
Silicox Radio & Television Corp., 60 Wall Tower, New York, N. Y.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Sundt Engineering Co., 4757 Ravenswood Ave., Chicago, Ill.
Technical Products International, 135 Liberty St., New York, N. Y.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
Triumph Mfg. Co., 4016 W. Lake St., Chicago, Ill.
Universal Microphone Co., Centinela at Warren Lane, Inglewood, Cal.
Vibraloc Mfg. Co., 1273 Mission St., San Francisco, Cal.
Webster-Chicago Corp., 5622 Bloomingdale Ave., Chicago, Ill.
(See Rauland Corp.)
Webster Electric Co., DeKoven Ave. & Clark St., Racine, Wis.
Western Electric Co., 300 Central Ave., Kearny, N. Y.
Western Sound & Electric Laboratories, Inc., 311 W. Kilbourn Ave., Milwaukee, Wis.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

PUBLIC ADDRESS SYSTEMS—see Systems, Complete Sound

Tape

CELLULOSE TAPE

Minnesota Mining & Mfg. Co., 900 Fauquier Ave., St. Paul, Minn.

Tape

(continued)

COTTON or SILK TAPE

Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
Carolina Narrow Fabric Co., 1036 N. Chestnut St., Winston-Salem, N. C.
Elizabeth Webbing Mills, Pawtucket, R. I.
General Electric Co., Schenectady, N. Y.
Hope Webbing Co., Providence, R. I.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Krout & Fite Mfg. Co., Allegheny Ave. & Emeral St., Philadelphia, Pa.
Lambeth Pope Corp., New Bedford, Mass.
Linton & Bro., Horace, 3081 Ruth St., Philadelphia, Pa.
Priscilla Braid Co., 1309 Broad St., Central Falls, R. I.
Sidebotham, Inc., John, 4317 Griscom St., (Frankford) Philadelphia, Pa.
Southern Weaving Co., Greenville, S. C.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

VARNISHED TAPE

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Nepperhan Sales Co., 175 Fifth Ave., New York, N. Y. (Sole Distributors for Vap-O-Lite Products Co., Astoria, N. Y.)
New Jersey Wood Finishing Co., Electrical Insulation Dept., Woodbridge, N. J.
Pearce Co., R. T., 235 Scott Blvd., Covington, Ky.
Respro, Inc., Wellington Ave., Cranston, R. I.
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Sullivan & Sons Mfg. Co., J., 2224 N. Ninth St., Philadelphia, Pa.
Vap-O-Lite Products Co.—see Nepperhan Sales Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Terminals and Strips

see Posts, Binding

Testers

BATTERY TESTERS

Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
Precision Thermometer & Instrument Co., 1434 Brandywine St., Philadelphia, Pa.
Rascher & Betzold, 835 Orleans St., Chicago, Ill.
Rieker Instrument Co., 1919 Fairmount Ave., Philadelphia, Pa.
Ruth Class Div., Kimble Glass Co., Conshohocken, Pa.
Testrite Instrument Co., 57 E. 11th St., New York, N. Y.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

CONDENSER TESTERS

Aerovox Corp., New Bedford, Mass.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Cornell-Dubilier Electric Corp., 1000 Hamilton Blvd., South Plainfield, N. J.
Deutschmann Corp., Tobe, Canton, Mass.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
RCA Mfg. Co., Camden, N. J.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

ELECTRICAL METER TESTERS

American Automatic Electric Sales Co., 1033 W. Van Buren St., Chicago, Ill.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Biddle Co., James G., 1213 Arch St., Philadelphia, Pa.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Deutschmann Corp., Tobe, Canton, Mass.
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
Electrical Facilities, Inc., 4224 Holden St., Oakland, Pa.
Ferris Instrument Corp., Boonton, N. J.
General Electric Co., Schenectady, N. Y.
Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.
McFarlin Co., 29 W. Marion Ave., Youngstown, Ohio
Measurements Corp., Boonton, N. J.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
States Co., 19 New Park Ave., Hartford, Conn.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

FIELD STRENGTH MEASURING TESTERS—see Testers, Electrical Meter

GROUND RESISTANCE TESTERS —see Testers, Electrical Meter

HEARING TESTERS

Aurex Corp., 1115 N. Franklin St., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43rd St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Maico Co., Inc., 2632 Nicollet Ave., Minneapolis, Minn.
McKesson Appliance Co., 2226 Ashland Ave., Toledo, Ohio
Sonotone Corp., Elmsford, N. Y.
Stoelting Co., C. H., 424 N. Homan Ave., Chicago, Ill.
Western Electric Co—see Graybar Electric Co.

HIGH VOLTAGE TESTERS

American Transformer Co., 178 Emmet St., Newark, N. J.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Ideal Commutator Dresser Co., 1631 Park Ave., Sycamore, Ill.
Miller Co., Bertrand F., Trenton, N. J.
Raytheon Mfg. Co., Waltham, Mass.
Roller-Smith Co., Bethlehem, Pa.
States Co., 19 New Park Ave., Hartford, Conn.
United Transformer Corp., 150 Varick St., New York, N. Y.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

INSULATION TESTERS

Associated Research, 431 South Dearborn St., Chicago, Ill.
(See Advertisement Page 143)

MAGNETIC TESTERS and TESTING MACHINES

Annis Co., R. B., 1505 E. Michigan St., Indianapolis, Ind.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Baird Associates, 20 Palmer St., Cambridge, Mass.
Commercial Engineering Laboratories, 4612 Woodward Ave., Detroit, Mich.
General Electric Co., Schenectady, N. Y.
Magnetic Analysis Corp., 42–44 12th St., Long Island City, N. Y.
Pioneer Instrument Div. of Bendix Aviation Corp., Bendix, N. J.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.

RADIO SET TESTERS—see Analyzers, Radio Set

TUBE TESTERS

Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Dayco Radio Corp., 915 Valley St., Dayton, Ohio
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Precision Resistor Co., 334 Badger Ave., Newark, N. J.
Radio City Products Co., 88 Park Pl., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Readrite Meter Works, College Ave., Bluffton, Ohio
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Standard Technical Devices, Inc., 3008 Ave. M, Brooklyn, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Webber Co., Earl, 4358 W. Roosevelt Rd., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Thermocouples

VACUUM THERMOCOUPLES

American Electrical Sales Co., 67 E. Eighth St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Field Electric Instrument Co., 2258 Morris Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Sensitive Research Instrument Co., 4545 Bronx Blvd., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
Xervac Instrument Co., 9 New Park Ave., Hartford, Conn.

Timers

AUTOMATIC CYCLE TIMERS

American Gas Accumulator Co., Electrical Div., Elizabeth, N. J.
Autocall Co., Shelby, Ohio
Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., 4428 Wayne Ave., Philadelphia, Pa.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
(See Advertisement Page 116)
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Foxboro Co., Neponset Ave., Foxboro, Mass.
Hanlon-Waters, Inc., Tulsa, Okla.
Industrial Instrument Co., 2249 14th St., S. W., Akron, Ohio
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Penn Electric Switch Co., Goshen, Ind.
Sangamo Electric Co., Springfield, Ill.
Stromberg Electric Co., 233 W. Erie St., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Taylor Instrument Companies, 100 Ames St., Rochester, N. Y.
Thomas Clocks, Seth, Div. General Time Instruments Corp., S. Main St., Thomaston, Conn.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Warren Telechron Co., 252 Main St., Ashland, Mass.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

AUTOMATIC INTERVAL TIMERS

American Gas Accumulator Co., Electrical Div., Elizabeth, N. J.
American Timer Corp., Geneva, Ill.
Automatic Electric Mfg. Co., 729 S. Front St., Mankato, Minn.
Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Controls, Inc., Towaco, N. J.
Cramer Co., R. W., Centerbrook, Conn.
(See Advertisement Page 116)
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
Electric Switch Corp., 14th at Union St., Columbus, Ind.
Fink-Roselieve Co., 109 W. 64th St., New York, N. Y.
Foxboro Co., Neponset Ave., Foxboro, Mass.
Frober-Faybor Co., Chagrin Falls, Ohio
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Glogau & Co., Rand McNally Bldg., Chicago, Ill.
Guardian Electric Mfg. Co., 1627 W. Walnut St., Chicago, Ill.
Industrial Engineering Corp., Evansville, Ind.
Industrial Timer Corp., 117 Edison Pl., Newark, N. J.
(See Advertisement Page 150)
Lektra Laboratories, Inc., 30 E. Tenth St., New York, N. Y.
Luers, J. Milton, 12 Pine St., Mt. Clemens, Mich.
Minneapolis-Honeywell Regulator Co., 2712 Fourth Ave., S., Minneapolis, Minn.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Perfex Corp., 415 W. Oklahoma Pl., Milwaukee, Wis.
Production Instrument Co., 710 W. Jackson Blvd., Chicago, Ill.
Standard Electric Time Co., 89 Logan St., Springfield, Mass.
Stromberg Electric Co., 233 W. Erie St., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Thomas Clocks, Seth, Div. General Time Instruments Corp., S. Main St., Thomaston, Conn.
Thompson Clock Co., H. C., 38 Federal St., Bristol, Conn.
Walser Automatic Timer Co., 420 Lexington Ave., New York, N. Y.
Warren Telechron Co., 252 Main St., Ashland, Mass.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

AUTOMATIC RESET TIMERS

American Gas Accumulator Co., Electrical Div., Elizabeth, N. J.
Automatic Electric Mfg. Co., 729 S. Front St., Mankato, Minn.
Automatic Temperature Control Co., 33 E. Logan St., Philadelphia, Pa.
Betts & Betts Corp., 551 W. 52d St., New York, N. Y.
Bristol Co., Waterbury, Conn.
Cramer Co., R. W., Centerbrook, Conn.
(See Advertisement Page 116)
Dunn, Inc., Struthers, 1315 Cherry St., Philadelphia, Pa.
Edison Electrical Controls, 51 Lakeside Ave., West Orange, N. J.
Guardian Electric Mfg. Co., 1627 W. Walnut St., Chicago, Ill.
Mason-Neilan Regulator Co., 1190 Adams St., Boston, Mass.
Paragon Electric Co., 37 W. Van Buren St., Chicago, Ill.
Production Instrument Co., 710 W. Jackson Blvd., Chicago, Ill.
Stromberg Electric Co., 233 W. Erie St., Chicago, Ill.
Tagliabue Mfg. Co., C. J., Park & Nostrand Aves., Brooklyn, N. Y.
Taylor Instrument Companies, 100 Ames St., Rochester, N. Y.
Warren Telechron Co., 252 Main St., Ashland, Mass.
Zenith Electric Co., 845 S. Wabash St., Chicago, Ill.

AUTOMATIC SPOT WELD TIMERS

Allen-Bradley Co., 1326 S. Second St., Milwaukee, Wis.
American Gas Accumulator Co., Electrical Div., Elizabeth, N. J.
Cramer Co., R. W., Centerbrook, Conn.
(See Advertisement Page 116)
Cutler-Hammer, Inc., 1401 W. St. Paul Ave., Milwaukee, Wis.
Electric Controller & Mfg. Co., 2701 E. 79th St., Cleveland, Ohio
General Electric Co., Schenectady, N. Y.
United Cinephone Corp., Torrington, Conn.

T-Pads

T-PADS

General Radio Co., 30 State St., Cambridge, Mass.
Daven Co., The, 158 Summit St., Newark, N. J.
Tech Labs, 7 Lincoln St., Jersey City, N. J.
(See Advertisement Page 146)

Transformers

CURRENT TRANSFORMERS

Acme Electric & Mfg. Co., 16 Water St., Cuba, N. Y.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
(See Advertisement Page 69)
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Arlavox Mfg. Co., 430 S. Green St., Chicago, Ill.
Chicago Transformer Corp., 3501 W. Addison St., Chicago, Ill.
Davis & Co., Dean W., 549 W. Fulton St., Chicago, Ill.
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Dongan Electric Mfg. Co., 2987 Franklin St., Detroit, Mich.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
(See Advertisement Page 149)
Eastern Specialty Co., 3619 N. Eighth St., Philadelphia, Pa.
Electrical Facilities, Inc., 4224 Holden St., Oakland, Cal.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
(See Advertisement Page 115)
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Controls Co., 801 Allen Ave., Glendale, Cal.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
(See Advertisement Page 128)
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Marine Radio Corp., 117 168th St., Jamaica, N. Y.
New York Transformer Co., 480 Lexington Ave., New York, N. Y.
(See Advertisement Page 125)
Norwalk Transformer Corp., South Norwalk, Conn.
Oxford-Tartak Radio Corp., 915 W. Van Buren St., Chicago, Ill.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Rubicon Co., 29 N. Sixth St., Philadelphia, Pa.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Superior Electric Co., 32 Harrison St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
(See Advertisement Page 111)
Tilton Electric Corp., 15 E. 26th St., New York, N. Y.
United Transformer Corp., 150 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Western Electro-Mechanical Co., 300 Broadway, Oakland, Cal.

INSTRUMENT TRANSFORMERS

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Transformer Co., 178 Emmet St., Newark, N. J.
(See Advertisement Page 69)
Condit Works, Allis-Chalmers Mfg. Co., Hyde Park Station, Boston, Mass.
Duncan Electric Co., 244 S. Third St., Lafayette, Ind.
Electrical Facilities, Inc., 4224 Holden St., Oakland, Cal.
Erie Electric Co., 124 Church St., Buffalo, N. Y.
Esterline-Angus Co., (Speedway City) Indianapolis, Ind.
Gardner Electric Mfg. Co., 4227 Hollis St., Emeryville, Cal.
General Electric Co., Schenectady, N. Y.
H D Electric Co., 100 W. Monroe St., Chicago, Ill.
Johnson Co., E. F., Waseca, Minn.
Newark Transformer Co., 17 Frelinghuysen Ave., Newark, N. J.
Niagara Electric Improvement Corp., 122 E. 42d St., New York, N. Y.
Roller-Smith Co., Bethlehem, Pa.
Sangamo Electric Co., Springfield, Ill.
Sparkes Mfg. Co., 318 Jefferson St., Newark, N. J.
Standard Transformer Co., 140 Dana St., N.E., Warren, Ohio
States Co., 3 New Park Ave., Hartford, Conn.
Surges Electric Co., 101 E. Seeboth St., Milwaukee, Wis.
Uptegraff Mfg. Co., R. E., Scottdale, Pa.
Wagner Electric Corp., 6400 Plymouth Ave., St. Louis, Mo.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

I. F. TRANSFORMERS

Aladdin Radio Industries, Inc., 468 W. Superior St., Chicago, Ill.
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
(See Advertisement Page 69)
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Automatic Windings Co., 900 Passaic Ave., East Passaic, N. J.
D-X Radio Products Co., 1575 Milwaukee Ave., Chicago, Ill.
General Mfg. Co., 1255 S. Michigan Ave., Chicago, Ill.
General Winding Co., 254 W. 31st St., New York, N. Y.
Guthman & Co., E. L., 400 S. Peoria St., Chicago, Ill.
Hammarlund Mfg. Co., 424 W. 33d St., New York, N. Y.
Hollywood Transformer Co., 645 N. Martel Ave., Los Angeles, Cal.
Meissner Mfg. Co., Mount Carmel, Ill.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Miller Co., J. W., 5917 S. Main St., Los Angeles, Cal.
Muter Co., 1255 S. Michigan Ave., Chicago, Ill.
National Co., 61 Sherman St., Malden, Mass.
Philco Radio & Television Corp., Tioga & C Sts., Philadelphia, Pa.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Sickles Co., F. W., 165 Front St., Chicopee, Mass.
Teleradio Engineering Corp., 484 Broome St., New York, N. Y.
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.

RECEIVER AUDIO & POWER TRANSFORMERS

Acme Electric & Mfg. Co., 16 Water St., Cuba, N. Y.
American Transformer Co., 178 Emmet St., Newark, N. J.
(See Advertisement Page 69)
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Audio Development Co., 123 Bryant Ave., N., Minneapolis, Minn.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
De Vry Corp., 1111 Armitage Ave., Chicago, Ill.
Division Coil Co., Calledonia, N. Y.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
(See Advertisement Page 149)
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
(See Advertisement Page 115)
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
Magnetic Windings Co., 16th & Butler Sts., Easton, Pa.
Marine Radio Corp., 117 168th St., Jamaica, N. Y.
New York Transformer Co., 480 Lexington Ave., New York, N. Y.
(See Advertisement Page 125)
Norwalk Transformer Corp., South Norwalk, Conn.
(See Advertisement Page 80)

Transformers

RECEIVER AUDIO & POWER TRANSFORMERS (continued)

Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Radex Corp., 1733 Milwaukee Ave., Chicago, Ill.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Superior Electric Co., 32 Harrison St., Bristol, Conn.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
(See Advertisement Page 111)
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

TRANSMITTER TRANSFORMERS

American Transformer Co., 178 Emmet St., Newark, N. J.
(See Advertisement Page 69)
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Collins Radio Co., 2920 First Ave., Cedar Radips, Iowa
Coto-Coil Co., 71 Willard Ave., Providence, R. I.
Doyle, Inc., James W., 311 N. Desplaines St., Chicago, Ill.
Freed Transformer Co., 72 Spring St., New York, N. Y.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
Insuline Corp. of America, 30–30 Northern Blvd., Long Island City, N. Y.
Jefferson Electric Co., Bellwood, Ill.
Kenyon Transformer Co., 840 Barry St., New York, N. Y.
(See Advertisement Page 128)
Marine Radio Corp., 117 168th St., Jamaica, N. Y.
Norwalk Transformer Corp., South Norwalk, Conn.
(See Advertisement Page 80)
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
(See Advertisement Page 111)
United Transformer Corp., 150 Varick St., New York, N. Y.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.

VOLTAGE REGULATING TRANSFORMERS

Acme Electric & Mfg. Co., 16 Water St., Cuba, N. Y.
(See Advertisement Page 131)
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Transformer Co., 178 Emmet St., Newark, N. J.
(See Advertisement Page 69)
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Audio Development Co., 123 Bryant Ave., N., Minneapolis, Minn.
Clark Controller Co., 1146 E. 152d St., Cleveland, Ohio
Freed Transformer Co., 72 Spring St., New York, N. Y.
General Transformer Corp., 1250 W. Van Buren St., Chicago, Ill.
Hadley Co., Robert M., 711 E. 61st St., Los Angeles, Cal.
Halldorson Co., 4500 Ravenswood Ave., Chicago, Ill.
International Transformer Co., 17 W. 20th St., New York, N. Y.
Marine Radio Corp., 117 168th St., Jamaica, N. Y.
Norwalk Transformer Corp., South Norwalk, Conn.
(See Advertisement Page 80)
Raytheon Mfg. Co., 190 Willow St., Waltham, Mass.
(See Advertisement Page 122)
RCA Mfg. Co., Camden, N. J.
Skaggs Transformer Co., 5894 Broadway, Los Angeles, Cal.
Sola Electric Co., 2525 Clybourn Ave., Chicago, Ill.
(See Advertisement Page 139)
Standard Electrical Products Co., 417 First Ave., N., Minneapolis, Minn.
Standard Transformer Corp., 1500 N. Halsted St., Chicago, Ill.
Superior Electric Co., 32 Harrison St., Bristol, Conn.
(See Advertisement Page 137)
Thordarson Electric Mfg. Co., 500 W. Huron St., Chicago, Ill.
(See Advertisement Page 111)
United Transformer Corp., 150 Varick St., New York, N. Y.
Ward Leonard Electric Co., 32 South St., Mount Vernon, N. Y.

Transmitters

AIRCRAFT TRANSMITTERS

Air Radio & Instrument Co., 5214 W. 63d St., Chicago, Ill.
Aircraft Radio Corp., Boonton, N. J.
Airplane & Marine Direction Finder Corp., Clearfield, Pa.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hallicrafters, Inc., 2611 S. Indiana Ave., Chicago, Ill.
(See Advertisement Page 81)
Harvey-Wells Communications, Inc., Southbridge, Mass.
International Telephone Development Co., 137 Varick St., New York, N. Y.
Lear Aviation, Inc., Dayton Municipal Airport, Dayton, Ohio
Link, Fred M., 125 W. 17th St., New York, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Radio Frequency Laboratories, Inc., Boonton, N. J.
Radio Navigational Instrument Corp., 500 Fifth Ave., New York, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Sparks-Withington Co., North St., Jackson, Mich.
Taylor Airphone Products, Inc., Municipal Airport, Long Beach, Cal.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

COMPLETE UNIT TRANSMITTERS

Barker & Williamson, Ardmore, Pa.
Bendix Radio Corp., 920 E. Fort Ave., Baltimore, Md.
Bud Radio, Inc., 2118 E. 55th St., Cleveland, Ohio
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Doolittle Radio, Inc., 7421 S. Loomis Blvd., Chicago, Ill.
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Gates Companies, Quincy, Ill.
General Electric Co., 1 River Road, Schenectady, N. Y.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
(See Advertisement Page 81)
Harvey-Wells Communications, Inc., Southbridge, Mass.
Johnson Co., E. F., Waseca, Minn.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Millen Mfg. Co., James, 150 Exchange St., Malden, Mass.
Radio Engineering Laboratories, Inc., 35–54 36th St., Long Island City, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
Radio Transceiver Laboratories, 120–03 Jamaica Ave., Richmond Hill, N. Y.
RCA Mfg. Co., Camden, N. J.
Selectar Mfg. Corp., 30 W. 15th St., New York, N. Y.
Skifter, Hector R., St. Paul Hotel, St. Paul, Minn.
Smith Co., Maxwell, 1027 N. Highlands Ave., Hollywood, Cal.
Taylor Tubes, Inc., 2341 Wabansia Ave., Chicago, Ill.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

FACSIMILE TRANSMITTERS

Finch Telecommunications, Inc., Passaic, N. J.
RCA Mfg. Co., Camden, N. J.

FM TRANSMITTERS

Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
General Electric Co., 1 River Rd., Schenectady, N. Y.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Link, Fred M., 125 W. 17th St., New York, N. Y.
Radio Engineering Laboratories, Inc., 35–54 36th St., Long Island City, N. Y.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Western Electric Co.—see Graybar Electric Co.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

MARINE TRANSMITTERS

Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Gates Companies, 200 Block Hampshire St., Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributors for Western Electric Co., New York, N. Y.)
Hallicrafters Co., 2611 Indiana Ave., Chicago, Ill.
(See Advertisement Page 81)
Harvey-Wells Communications, Inc., Southbridge, Mass.
International Telephone Development Co., 137 Varick St., New York, N. Y.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Link, Fred M., 125 W. 17th St., New York, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Radio Receptor Co., 251 W. 19th St., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.

MOBILE TRANSMITTERS

Gates Companies, 200 Block Hampshire St., Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Harvey-Wells Communications, Inc., Southbridge, Mass.
Link, Fred M., 125 W. 17th St., New York, N. Y.
Majestic Radio & Television Corp., 2600 W. 50th St., Chicago, Ill.
Radio Engineering Laboratories, Inc., 35–54 36th St., Long Island City, N. Y.
Radio Transceiver Laboratories, 120–03 Jamaica Ave., Richmond Hill, N. Y.
RCA Mfg. Co., Camden, N. J.
Western Electric Co—see Graybar Electric Co.
Wilcox Electric Co., 40th & State Line, Kansas City, Mo.

POLICE TRANSMITTERS

Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
Galvin Mfg. Corp., 4545 Augusta Blvd., Chicago, Ill.
Gates Companies, 200 Block Hampshire St., Quincy, Ill.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Harvey-Wells Communications, Inc., Southbridge, Mass.
Kaar Engineering Co., 619 Emerson St., Palo Alto, Cal.
Link, Fred M., 125 W. 17th St., New York, N. Y.
National Co., 61 Sherman St., Malden, Mass.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.

RCA Mfg. Co., Camden, N. J.
Stromberg-Carlson Telephone Mfg. Co., 100 Carlson Rd., Rochester, N. Y.
Transmitter Equipment Mfg. Co., 130 Cedar St., New York, N. Y.
Western Electric Co.—see Graybar Electric Co.

PORTABLE PICKUP TRANSMITTERS

Gates Companies, 200 Block Hampshire St., Quincy, Ill.
Radio Engineering Laboratories, Inc., 35–54 36th St., Long Island City, N. Y.
RCA Mfg. Co., Camden, N. J.

RELAY BROADCAST TRANSMITTERS

Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
General Electric Co., 1 River Rd., Schenectady, N. Y.
Harvey-Wells Communications, Inc., Southbridge, Mass.
Radio Engineering Laboratories, Inc., 35–54 36th St., Long Island City, N. Y.
RCA Mfg. Co., Camden, N. J.

TELEVISION TRANSMITTERS

Du Mont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Fort Wayne, Ind.
General Electric Co., 1 River Rd., Schenectady, N. Y.
RCA Mfg. Co., Camden, N. J.

Tubes

CATHODE RAY TUBES

American Television Corp., 130 W. 56th St., New York, N. Y.
DuMont Laboratories, Inc., Allen B., 2 Main Ave., Passaic, N. J.
Farnsworth Television & Radio Corp., 3700 Pontiac St., Ft. Wayne, Ind.
General Electric Co., Schenectady, N. Y.
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass.
RCA Mfg. Co., Camden, N. J.
Vacutron, Inc., 20 W. 22d St., Arlington, Va.
Western Electric Co.—see Graybar Electric Co.

CURRENT REGULATING TUBES (Ballast)

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Amperite Co., 561 Broadway, New York, N. Y.
Art Radio Corp., 115 Liberty St., New York, N. Y.
Champion Radio Works, Div. of Consolidated Electric Lamp Co., Danvers, Mass.
Hytron Corp., & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
RCA Mfg. Co., Camden, N. J.

DIODE RECEIVING TUBES — see **Tubes,** Receiving

DISCHARGE TUBES — see **Tubes,** Industrial

FULL-WAVE RECTIFIER RECEIVING TUBES—see **Tubes,** Receiving

GRID CONTROLLED RECTIFIER TUBES—see **Tubes,** Industrial

HALF-WAVE RECTIFIER RECEIVING TUBES—see **Tubes,** Receiving

HEARING AID TUBES

Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
Raytheon Production Corp., 55 Chapel St., Newton, Mass.
RCA Mfg. Co., Camden, N. J.

HIGH VACUUM RECTIFIER TUBES—see **Tubes,** Receiving

INDUSTRIAL TUBES

Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y.
Clark Controller Co., 1146 E. 52d St., Cleveland, Ohio
Continental Electric Co., 715 Hamilton St., Geneva, Ill.
(See Advertisement Page 130)
Electrons, Inc., 127 Sussex Ave., Newark, N. J.
General Electric Co., 1 River Rd., Schenectady, N. Y.
General Scientific Corp., 4829 S. Keedzie Ave., Chicago, Ill.
Heintz & Kaufman, Ltd., South San Francisco, Cal.
Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
National Union Radio Corp., 57 State St., Newark, N. J.
Photovolt Corp., 95 Madison Ave., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Taylor Tubes, Inc., 2341 Wabansia Ave., Chicago, Ill.
United Electronics Co., 42 Spring St., Newark, N. J.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.

MULTI-ELEMENT RECEIVING TUBES—see **Tubes,** Receiving

PENTODE RECEIVING TUBES—see **Tubes,** Receiving

RECEIVING TUBES

General Electric Co., Schenectady, N. Y.
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass.
Hytron Corp., & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
(See Advertisement Page 134)
Ken-Rad Tube & Lamp Corp., Owensboro, Ky.
National Union Radio Corp., 57 State St., Newark, N. J.
Raytheon Production Corp., 55 Chapel St., Newton, Mass.
RCA Mfg. Co., Camden, N. J.
(See Advertisement on Back Cover)
Tungsol Lamp Works, Inc., 95 Eighth Ave., Newark, N. J.
United Electronics Co., 42 Spring St., Newark, N. J.
Zenith Radio Corp., 6001 Dickens Ave., Chicago, Ill.

RECTIFIER TUBES — see **Tubes,** Industrial
also **Tubes,** Receiving

TETRODE RECEIVING TUBES—see **Tubes,** Receiving

TRANSMITTING TUBES

Amperex Electronic Products, 79 Washington St., Brooklyn, N. Y.
(See Advertisement Inside Front Cover)
Collins Radio Co., 2920 First Ave., Cedar Rapids, Iowa
Eitel-McCullough, Inc., San Bruno, Cal.
(See Advertisement Page 28)
Federal Telegraph Co., 200 Mt. Pleasant Ave., Newark, N. J.
General Electric Co., Schenectady, N. Y.
(See Advertisements Pages 7, 9, 15)
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Heintz and Kaufman, South San Francisco, Cal.
(See Advertisement Page 87)
Hytron Corp. & Hytronic Laboratories, 76 Lafayette St., Salem, Mass.
(See Advertisement Page 134)
Radio Specialties Co., 1956 Figueroa St., San Francisco, Cal.
Raytheon Production Corp., 55 Chapel St., Waltham, Mass.
RCA Mfg. Co., Camden, N. J.
Taylor Tubes, Inc., 2341 Wabansia Ave., Chicago, Ill.
(See Advertisement Page 17)
United Electronics Co., 42 Spring St., Newark, N. J.
(See Advertisement Page 9)
Western Electric Co.—see Graybar Electric Co.
Westinghouse Lamp Div., Westinghouse Electric & Mfg. Co., Bloomfield, N. J.
(See Advertisement Page 26)

TRIODE RECEIVING TUBES—see **Tubes,** Receiving

VOLTAGE DOUBLING RECTIFIER RECEIVING TUBES—see **Tubes,** Receiving

VOLTAGE REGULATING TUBES

Amperite Co., 561 Broadway, New York, N. Y.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass.
RCA Mfg. Co., Camden, N. J.

X-RAY TUBES

Adlanco X-Ray Corp., 54 Lafayette St., New York, N. Y.
Fischer & Co., H. G., 2323 Wabansia Ave., Chicago, Ill.
General Electric X-Ray Corp., 2012 Jackson Blvd., Chicago, Ill.
Kelley-Koett Mfg. Co., Covington, Ky.
Machlett Laboratories, Springdale, Conn.
Philips Metalix Corp., 419 Fourth Ave., New York, N. Y.
Standard X-Ray Co., 1930 N. Burling St., Chicago, Ill.
Westinghouse X-Ray Co., 21–16 43d Ave., Long Island City, N. Y.
(See Advertisement Page 26)

Tubes and Tubing

BRASS and COPPER TUBES and TUBING

American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., E. Main St., Bridgeport, Conn.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Mueller Brass Co., 1925 Lapeer Ave., Port Huron, Mich.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
(See Advertisement Page 114)
Revere Copper & Brass, Inc., 230 Park Ave., New York, N. Y.
Scovill Mfg. Co., 99 Mill St., Waterbury, Conn.
Universal Brass Works, Howard & Lehigh Ave., Philadelphia, Pa.
Wolverine Tube Co., 1411 Central Ave., Detroit, Mich.

CERAMIC TUBES and TUBING— see **Cores,** Resistor
also **Porcelain,** Molders of

GLASS TUBES and TUBING

Bentley-Harris Mfg. Co., 100 Hector St., Conshohocken, Pa.
(See Advertisement Page 135)
Corning Glass Works, Corning, N. Y.
Duro-Test Corp., North Bergen, N. J.
Hygrade Sylvania Corp., 60 Boston St., Salem, Mass.
Luminous Laboratories, Inc., 6 E. Lake St., Chicago, Ill.
Riedel Glass Works, Inc., Jos., 261 Fifth Ave., New York, N. Y.
St. Charles Technical Laboratories, Inc., 10 State Ave., St. Charles, Ill.

KNITTED WIRE TUBES and TUBING

Alden Products Co., 715 Center St., Brockton, Mass.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 71)
Camden Wire Co., Camden, N. Y.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
Hope Webbing Co., Providence, R. I.
New England Electrical Works, 365 Main St., Lisbon, N. H.
Roebling's Sons Co., John A., Trenton, N. J.

PAPER TUBES and TUBING

American Paper Tube Co., Hazel St., Woonsocket, R. I.
Cleveland Container Co., 10630 Berea Rd., Cleveland, Ohio
Cross Paper Products Corp., 2595 Third Ave., New York, N. Y.
Franklin Fibre-Lamitex Corp., 12th & French Sts., Wilmington, Del.
General Paper Tube Co., 430 E. Chelton Ave., Philadelphia, Pa.
Pairpoint Corp., Prospect St., New Bedford, Mass.
Paramount Paper Tube Co., 801 Glasgow Ave., Fort Wayne, Ind.
Precision Paper Tube Co., 2033 W. Charleston St., Chicago, Ill.
Sonoco Products Co., Hartsville, S. C.
Stone Paper Tube Co., 900 Franklin St., N. E., Washington, D. C.

PHENOLIC TUBES and TUBING— see **Insulation,** Phenolic

VARNISHED FABRIC TUBES and TUBING

Anchor Webbing Co., 1005 Main St., Pawtucket, R. I.
B-C Insulation Products, Inc., 22 W. 21st St., New York, N. Y.
Bentley, Harris Mfg. Co., 1000 Hector St., Conshohocken, Pa.
(See Advertisement Page 135)
Brand & Co., William, 276 Fourth Ave., New York, N. Y.
(See Advertisement Page 2)
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Insulation Products, Inc., 22 W. 21st St., New York, N. Y.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Nepperhan Sales Co., 175 Fifth Ave., New York, N. Y. (Sole Distributors for Vap-O-Lite Products Co., Astoria, N. Y.)
Pearce Co., R. T., 235 Scott Blvd., Covington, Ky.

Tubes and Tubing

VARNISHED FABRIC TUBES AND TUBING (continued)

Surprenant Electrical Insulation Co., 84 Purchase St., Boston, Mass.
Vap-O-Lite Products Co.—see Nepperhan Sales Co.
Varflex Corp., Cor. Ford & Floral Sts., Rome, N. Y.

VULCANIZED FABRIC TUBES and TUBING—see Fibre, Vulcanized

Tubing

HEAT RESISTING GLASS TUBING —see Tubes and Tubing

PURE NICKEL AND NICKEL ALLOY TUBING

Admak Mfg. Co., Irvington, N. J.
Driver-Harris Co., Harrison, N. J.
General Plate Co., Attleboro, Mass.
International Nickel Co., 67 Wall St., New York, N. Y.
Summerill Tubing Co., Bridgeport, Pa.
Superior Tube Co., Norristown, Pa. (See Advertisement Page 24)

ULTRA VIOLET GLASS TUBING— —see Tubes and Tubing

Turntables

PHONOGRAPH and TRANSCRIPTION TURNTABLES

Alliance Mfg. Co., Lake Park Blvd., Alliance, Ohio
Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
Amplifier Co. of America, 17 W. 20th St., New York, N. Y.
Bateman Sound Systems, 680 Johnston St., Akron, Ohio
Chicago Sound Systems Co., 251 E. Grand Ave., Chicago, Ill.
Duplex Recording Devices Co., 1041 Manor Ave., New York, N. Y.
Dynavox Corp., 55 E. 11th St., New York, N. Y.
Electrical Industries Mfg. Co., Red Bank, N. J.
Electro Acoustic Co., 2131 Bueter Rd., Fort Wayne, Ind.
Fairchild Aviation Corp., 88-06 Van Wyck Blvd., Jamaica, N. Y.
Gates Companies, 200 Block Hampshire St., Quincy, Ill.
General Communication Products Co., Lexington Ave. at Vine, Hollywood, Cal.
General Industries Co., 3537 Taylor St., Elyria, Ohio
Graybar Electric Co., Lexington Ave. at 43d St., New York, N. Y. (Sole Distributor for Western Electric Co., New York, N. Y.)
Harris Mfg. Co., 2422 W. Seventh St., Los Angeles, Cal.
Mellaphone Corp., 65 Atlantic Ave., Rochester, N. Y.
Mirror Record Corp., 58 W. 25th St., New York, N. Y.
Music Master Mfg. Co., 508 S. Dearborn St., Chicago, Ill.
Pacent Engineering Corp., 79 Madison Ave., New York, N. Y.
Pan-American Record Co., 705 S. First St., Louisville, Ky.
Permo Products Corp., 6415 Ravenswood Ave., Chicago, Ill.
Presto Recording Corp., 242 W. 55th St., New York, N. Y. (See Advertisement Page 116)
Proctor Co., B. A., 230 Park Ave., New York, N. Y.
Radio Engineering Laboratories, Inc., 35-54 36th St., Long Island City, N. Y.
Radiotone, Inc., 7356 Melrose Ave., Hollywood, Cal.
Radolek Co., 601 W. Randolph St., Chicago, Ill.
Ray Lab, Inc., 211 Railroad Ave., Elmira, N. Y.
RCA Mfg. Co., Camden, N. J.
Regal Amplifier Mfg. Corp., 14 W. 17th St., New York, N. Y.
Rek-O-Kut Corp., 173 Lafayette St., New York, N. Y.
Robinson Recording Laboratories, 35 S. Ninth St., Philadelphia, Pa.
Smith Co., Maxwell, 1027 N. Highland Ave., Hollywood, Cal.
Sound Apparatus Co., 150 W. 46th St., New York, N. Y.
Speak-O-Phone Recording & Equipment Co., 23 W. 60th St., New York, N. Y.
Talking Devices Co., 4451 W. Irving Park Rd., Chicago, Ill.
Transformer Corp. of America, 69 Wooster St., New York, N. Y.
United Cinephone Corp., Torrington, Conn.
Universal Microphone Co., Inglewood, Cal.
Warner Co., J. J., 1244 Larkin St., San Francisco, Cal.
Waters-Conley Co., Rochester, Minn.
Western Electric Co.—see Graybar Electric Co.

Varnish

INSULATING VARNISH

Bakelite Corp., 30 E. 42d St., New York, N. Y.
Benolite Corp., Manor, Pa.
Day & Co., James B., 1872 Clybourn Ave., Chicago, Ill.
Dielectric Corp., 5520 Clemens St., St. Louis, Mo.
Dolph Co., John C., 168A Emmett St., Newark, N. J.
Durez Plastics & Chemicals, Inc., Walck Rd., North Tonawanda, N. Y.
Electric Power Construction, Inc., 569 S. Main St., Akron, Ohio
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
George Co., P. D., 4153 Bingham Ave., St. Louis, Mo.
Impervious Varnish Co., Rochester, Pa.
Industrial Paint Co., Haysville, Pa.
Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago, Ill.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J. (See Advertisement Page 98)
Kay & Ess Co., Leo & Kiser Sts., Dayton, Ohio
Lastik Products Co., American Bank Bldg., Pittsburgh, Pa.
Maas and Waldstein, 438 Riverside Ave., Newark, N. J. (See Advertisement Page 127)
Makalot Corp., 262 Washington St., Boston, Mass.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Ohmlac Paint & Refining Co., 6540 S. Central St., Chicago, Ill.
Robertson Chemical Co., 9808 Meech Ave., Cleveland, Ohio
Schenectady Varnish Co., Congress St., Schenectady, N. Y.
Sherwin-Williams Co., 101 Prospect Ave., N. W., Cleveland, Ohio
Standard Insulation Co., 74 Paterson Ave., East Rutherford, N. J.
Standard Varnish Works, 2600 Richmond Terrace, Staten Island, N. Y.
Sterling Varnish Co., Haysville, Pa.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zophar Mills, Inc., 118-26th St., Brooklyn, N. Y.

Vibrators

HOME and AUTO RADIO

Allied Radio Corp., 833 W. Jackson Blvd., Chicago, Ill.
American Television & Radio Corp., 300 E. 4th St., St. Paul, Minn.
Electrical Products Co., 6535 Russell St., Detroit, Mich.
Mallory & Co., P. R., 3029 E. Washington St., Indianapolis, Ind. (See Advertisement Page 32)
Oak Mfg. Co., 1260 Clybourn Ave., Chicago, Ill.
Radiart Corp., W. 62 St. & Barberton Ave., E. Cleveland, Ohio
Turner Co., Cedar Rapids, Iowa
United Motors Service, 3044 W. Grand Blvd., Detroit, Mich.
Utah Radio Products Co., 820 Orleans St., Chicago, Ill.
Vibrapowr, James, 341 N. Pulaski St., Chicago, Ill.

Volt-Ammeters

VOLT-AMMETERS

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
De Jur-Amsco Corp., Shelton, Conn.
Esterline-Angus Co., (Speedway City), Indianapolis, Ind.
General Electric Co., Schenectady, N. Y.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Supreme Instruments Corp., Greenwood, Miss.
Therm-Electric Meters Co., Ithaca, N. Y.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Voltmeters

VOLTMETERS

American Electrical Sales Co., 67 E. Eighth St., New York, N. Y.
Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Ballantine Laboratories, Inc., Boonton, N. J. (See Advertisement Page 120)
Burton-Rogers Co., 857 Boylston St., Boston, Mass. (Sole Distributors for Hoyt Electrical Instrument Works, Boston, Mass.)
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
De Jur-Amsco Corp., Shelton, Conn. (See Advertisement Page 117)
Electric Tachometer Corp., 1354 Spring Garden St., Philadelphia, Pa.
Electronic Laboratory, 306 S. Edinburgh Ave., Los Angeles, Cal.
Englehard, Inc., Charles, 90 Chestnut St., Newark, N. J.
Engineering Laboratories, Inc., 624 E. Fourth St., Tulsa, Okla.
Esterline-Angus Co. (Speedway City), Indianapolis, Ind.
Etna Electric Works, 410 E. 15th St., New York, N. Y.
Ferris Instrument Corp., Boonton, N. J. (See Advertisement Page 144)
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Geophysical Instrument Co., 1315 Half St., S. E., Washington, D. C.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Hoyt Electrical Instrument Works—see Burton-Rogers Co.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Measurements Corp., Boonton, N. J.
Million Radio & Television, 1617 N. Damen Ave., Chicago, Ill.
Norton Electrical Instrument Co., 79 Hilliard St., Manchester, Conn.
Potter Co., 1950 Sheridan Rd., North Chicago, Ill.
Radio City Products Co., 88 Park Pl., New York, N. Y.
RCA Mfg. Co., Camden, N. J.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Roller-Smith Co., Bethlehem, Pa.
Ruska & Co., Walter, 2332 Bellaire Blvd., Houston, Texas
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill. (See Advertisement Page 102)
Supreme Instruments Corp., Greenwood, Miss.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.
Wheelco Instruments Co., 2001 S. Halsted St., Chicago, Ill.

ELECTROSTATIC VOLTMETERS

Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Ferranti Electric, Inc., 30 Rockefeller Plaza, New York, N. Y.
General Electric Co., Schenectady, N. Y.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.

MEGOHM VOLTMETERS

Associated Research, Inc., 431 S. Dearborn St., Chicago, Ill.
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

VACUUM TUBE VOLTMETERS

Andrew, Victor J., 6429 S. Lavergne Ave., Chicago, Ill.
Ballantine Laboratories, Inc., Boonton, N. J.
(See Advertisement Page 120)
Cambridge Instrument Co., Grand Central Terminal, New York, N. Y.
Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
Ferris Instrument Corp., Boonton, N. J.
(See Advertisement Page 144)
Fisher Scientific Co., 711 Forbes St., Pittsburgh, Pa.
General Electric Co., Schenectady, N. Y.
General Radio Co., 30 State St., Cambridge, Mass.
Jones-Orme Co., 1645 Hennepin Ave., St. Paul, Minn.
Luxtrol Co., 54 W. 21st St., New York, N. Y.
Measurements Corp., Boonton, N. J.
Million Radio & Television, 1617 N. Damen Ave., Chicago, Ill.
(See Advertisement Page 141)
Radio City Products Co., 88 Park Pl., New York, N. Y.
Reliance Instrument Co., 1135 W. Van Buren St., Chicago, Ill.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Televiso Products, Inc., 2400 N. Sheffield Ave., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Volt-Ohmmeters

VOLT-OHMMETERS

Clough-Brengle Co., 5501 Broadway, Chicago, Ill.
De Jur-Amsco Corp., Shelton, Conn.
Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland, Ohio
Jackson Electrical Instrument Co., 129 Wayne Ave., Dayton, Ohio
Precision Apparatus Co., 647 Kent Ave., Brooklyn, N. Y.
Rawson Electrical Instrument Co., 102 Potter St., Cambridge, Mass.
RCA Mfg. Co., Camden, N. J.
Roller-Smith Co., Bethlehem, Pa.
Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York, N. Y.
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.
Simpson Electric Co., 5218 W. Kinzie St., Chicago, Ill.
Triplett Electrical Instrument Co., 286 Harmon Rd., Bluffton, Ohio
Triumph Mfg. Co., 4017 W. Lake St., Chicago, Ill.
Welch Mfg. Co., W. M., 1515 Sedgwick St., Chicago, Ill.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark, N. J.

Washers

LOCK WASHERS

American Nut & Bolt Fastener Co., 2045 Doerr St., Pittsburgh, Pa.
Clark Bros. Bolt Co., Millidale, Conn.
Eaton Mfg. Co., Reliance Spring Washer Div., Massillon, Ohio
Harper Co., H. M., 2630 Fletcher St., Chicago, Ill.
Hobbs Mfg. Co., 26 Salisbury St., Worcester, Mass.
Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis, Minn.
Line Material Co., 740 N. Second St., Milwaukee, Wis.
Manufacturers Screw Products, 222 W. Hubbard St., Chicago, Ill.
National Lock Washer Co., 40 Hermon St., Newark, N. J.
Palnut Co., 61 Cordier St., Irvington, N. J.
Philadelphia Steel & Wire Corp., Penn St. & Belfield Ave., Philadelphia, Pa.
Positive Lock Washer Co., 181 Miller St., Newark, N. J.
Shakeproof Lock Washer Co., 2565 N. Keeler Ave., Chicago, Ill.
Thompson-Bremer & Co., 1640 W. Hubbard St., Chicago, Ill.
Wrought Washer Mfg. Co., 2223 S. Bay St., Milwaukee, Wis.

Wax

WAX and COMPOUNDS

Allied Asphalt & Mineral Corp., 217 Broadway, New York, N. Y.
American Phenolic Corp., 1250 Van Buren St., Chicago, Ill.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
Austin Co., M. B., 108-116 S. Desplaines St., Chicago, Ill.
Bakelite Corp., 30 E. 42d St., New York, N. Y.
Benolite Corp., Manor, Pa.
Biwax Corp., 1017 S. Kolmar Ave., Chicago, Ill.
Candy & Co., 2515 W. 35th St., Chicago, Ill.
Cochrane Chemical Co., 432 Danforth Ave., Jersey City, N. J
Continental-Diamond Fibre Co., 13 Chapel St., Newark, Del.
Dolph Co., John C., 168A Emmett St., Newark, N. J.
duPont Plastics Dept., Arlington, N. J.
Electrical Engineers Equipment Co., 25th Ave. & Division St., Melrose Park, Ill.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Appliance and Merchandise Dept., Bridgeport, Conn.
Georgia Rosin Products Co., Savannah, Ga.
G & W Electric Specialty Co., 7780 Dante Ave., Chicago, Ill.
Halowax Corp., 247 Park Ave., New York, N. Y.
Impervious Varnish Co., Rochester, Pa.
Insil-X Co., 198 Lafayette Pl., Englewood, N. J.
Insulatine Co., 1 Broadway, New York, N. Y.
Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.
(See Advertisement Page 98)
Johns-Manville, 22 E. 40th St., New York, N. Y.
Line Material Co., 740 N. Second St., Milwaukee, Wis.
Maas and Waldstein Co., 438 Riverside Ave., Newark, N. J.
(See Advertisement Page 127)
McGill Mfg. Co., Box 670, Valparaiso, Ind.
Mica Insulator Co., 200 Varick St., New York, N. Y.
Mineralac Electric Co., 25 N. Peoria St., Chicago, Ill.
Mitchell-Rand Insulation Co., 51 Murray St., New York, N. Y.
Nukem Products Corp., 70 Niagara St., Buffalo, N. Y.
Okonite Co., Canal St., Passaic, N. J.
Pioneer Asphalt Co., 435 N. Michigan Ave., Chicago, Ill.
Robertson Chemical Co., 9808 Meech Ave., Cleveland, Ohio
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., Trenton, N. J.
Rusgreen Mfg. Co., 14262 Birwood Ave., Detroit, Mich.
Sauereisen Cements Co., Sharpsburg, Station, Pittsburgh, Pa.
Sterling Varnish Co., Haysville, Pa.
Trotter & Co., E. T., 594 Johnson Ave., Brooklyn, N. Y.
United States Rubber Co., 1230 Sixth Ave., New York, N. Y.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.
Zophar Mills, Inc., 112-26th St., Brooklyn, N. Y.
(See Advertisement Page 140)

Winders

COIL WINDERS—see Machines, Coil Winding

Windings

COIL WINDINGS—see Coils and Windings

Wire

HOOKUP WIRE

Acorn Insulated Wire Co., 225 King St., Brooklyn, N. Y.
Alden Products Co., 715 Center St., Brockton, Mass.
Alpha Wire Corp., 50 Howard St., New York, N. Y.
American Wire Div. of Electric Auto-Lite Co., 3529 24th St., Port Huron, Mich.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
(See Advertisement Page 13)
Belden Mfg. Co., 4647 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 71)
Birnbach Radio Co., 145 Hudson St., New York, N. Y.
Boston Insulated Wire & Cable Co., 65 Bay St., (Dorchester) Boston, Mass.
(See Advertisement Page 142)
Consolidated Wire & Associated Corps., Peoria & Harrison Sts., Chicago, Ill.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Insulated Wire & Cable Co., Trenton, N. J.
Electric Auto-Lite Co., Wire Div., 3529 24th St., Port Huron, Mich.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
Fleron & Son, Inc., M. M., 113 N. Broad St., Trenton, N. J.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Insulated Wire Corp., 53 Park Pl., New York, N. Y.
Insuline Corp. of America, 30-30 Northern Blvd., Long Island City, N. Y.
Lenz Electric Mfg. Co., 1751 N. Western Blvd., Chicago, Ill.
Lowell Insulated Wire Co., 171 Lincoln St., Lowell, Mass.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Precision Tube Co., 3828 Terrace St., Philadelphia, Pa.
(See Advertisement Page 114)
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.

MAGNET WIRE

Acme Wire Co., 1255 Dixwell Ave., New Haven, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
American Wire Div., Electric Auto-Lite Co., Port Huron, Mich.
Anaconda Wire & Cable Co., 25 Broadway, New York, N. Y.
(See Advertisement Page 13)
Ansonia Electrical Co., Ansonia, Conn.
Belden Mfg. Co., 4673 W. Van Buren St., Chicago, Ill.
(See Advertisement Page 71)
Bradford, Kyle & Co., Plymouth, Mass.
Chase Brass & Copper Co., 236 Grand St., Waterbury, Conn.
Cornish Wire Co., 15 Park Row, New York, N. Y.
Crescent Insulated Wire & Cable Co., Olden & Taylor Aves., Trenton, N. J.
Essex Wire Corp., 14310 Woodward Ave., Detroit, Mich.
General Cable Corp., 420 Lexington Ave., New York, N. Y.
General Electric Co., Schenectady, N. Y.
(See Advertisements Pages 7, 15, 19)
Holyoke Wire & Cable Corp., 720 Main St., Holyoke, Mass.
Kennecott Wire & Cable Co. (Phillipsdale), Providence, R. I.
Lenz Electric Mfg. Co., 1751 N. Western Ave., Chicago, Ill.
Massachusetts Electric Mfg. Co., 11 Margin St., West Lynn, Mass.
New England Electrical Works, 365 Main St., Lisbon, N. H.
Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.
Philadelphia Insulated Wire Co., 200 N. Third St., Philadelphia, Pa.
Rea Magnet Wire Co., E. Pontiac St., Fort Wayne, Ind.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Roebling's Sons Co., John A., Trenton, N. J.
Rome Cable Corp., 330 Ridge St., Rome, N. Y.
Wheeler Insulated Wire Co., 378 Washington Ave., Bridgeport, Conn.
Winsted Div. of Hudson Wire Co., Winsted, Conn.
(See Advertisement Page 134)

RESISTANCE and FILAMENT WIRE

Alloy Metal Wire Co., 13th St. & Pennsylvania Ave., Moore, Pa.
American Brass Co., Waterbury, Conn.
American Steel & Wire Co., Rockefeller Bldg., Cleveland, Ohio
Callite Tungsten Corp., 544 39th St., Union City, N. J.
Cohn, Sigmund, 44 Gold St., New York, N. Y.
(See Advertisement Page 12)
Driver Co., Wilbur B., 150 Riverside Ave., Newark, N. J.
(See Advertisement Page 139)
Driver-Harris Co., Harrison, N. J.
Hoskins Mfg. Co., 4447 Lawton Ave., Detroit, Mich.
Jelliff Mfg. Corp., C. O., 200 Pequot Ave., Southport, Conn.
Prentiss & Co., George W., 439 Dwight St., Holyoke, Mass.
Rockbestos Products Corp., 308 Nicoll St., New Haven, Conn.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

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